Correction Factors For Numbers of Released Chinook Salmon Reported in Commercial Troll Logbooks: Expanding the Applications of the Observer Program

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V9T 6N7

2010

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2898

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Canadian Manuscript Report of Fisheries and Aquatic Sciences

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Canadian Manuscript Report of
Fisheries and Aquatic Sciences 2898

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CORRECTION FACTORS FOR NUMBERS OF RELEASED CHINOOK SALMON REPORTED IN COMMERCIAL TROLL LOGBOOKS: EXPANDING THE APPLICATIONS OF THE OBSERVER PROGRAM

by

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Cat. No. Fs 97-4/2898E ISSN 0706-6473

Correct citation for this publication:

Vélez-Espino, L.A., McNicol, R.E, Brown, G., and Parken, C.K. 2010. Correction factors for numbers of released Chinook salmon reported in commercial troll logbooks: expanding the applications of the observer program. Can. Manuscr. Rep. Fish. Aquat. Sci. 2898: vii + 48 p.

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The need for accurate information on the number of Chinook salmon (*Oncorhynchus tschawytscha*) caught and released during fishing periods has become increasingly important with the Pacific Salmon Treaty now requiring both Canada and the United States of America to provide a measure of total mortality (fishing mortality plus incidental mortality) from salmon fisheries. The number of Chinook released is essential to estimate incidental mortality, which is the product of assumed post-release mortality and estimated number of Chinook released. Statistical analyses of data reported by observer and logbook programs in West Coast Vancouver Island (WCVI) troll fishery for the period 1998-2008 demonstrated that there is a consistent underreporting of released Chinook in retention periods in logbooks when trollers are allowed to keep only legal-size fish. The consistency of this bias across the study period translated into average correction factors of 1.33-1.67. The stability of the underreporting bias was demonstrated with two different approaches characterized by two different spatial-temporal stratifications (management area-license year and management area-statistical week) of observer and logbook datasets and two different statistical metrics (proportion of the encounters released and the number released per fishing effort). A third metric was explored (the ratio between the number released and the number kept) and considered suboptimum to explain the variability in observer data. The ability to correct underreporting of the number of released fish is important to more effectively assess incidental mortality rates in Chinook salmon troll fisheries, and is vital within a total mortality management regime in which fishers are accountable for legal and sublegal mortality.

RÉSUMÉ

Vélez-Espino, L.A., McNicol, R.E, Brown, G., and Parken, C.K. 2010. Correction factors for numbers of released Chinook salmon reported in commercial troll logbooks: expanding the applications of the observer program. Can. Manuscr. Rep. Fish. Aquat. Sci. 2898: vii + 48 p.

Il est de plus en plus important de disposer de données précises sur le nombre de saumons quinnats (*Oncorhynchus tschawytscha*) capturés et remis à l'eau durant les saisons de pêche maintenant que le Traité sur le saumon du Pacifique exige que le Canada et les États-Unis fournissent une mesure du niveau de mortalité totale (mortalité par pêche plus mortalité accidentelle) imputable aux pêches du saumon. Il est essentiel de connaître le nombre de saumons quinnats remis à l'eau pour être en mesure d'estimer la mortalité accidentelle, qui est le produit de la mortalité hypothétique après la remise à l'eau et du nombre estimatif de quinnats remis à l'eau. Des analyses statistiques des données sur la pêche aux lignes traînantes pratiquée sur la côte Ouest de l'île de Vancouver (COIV), recueillies dans le cadre des programmes des observateurs et des journaux de bord pendant la période 1998-2008, ont démontré qu'il existe une sous-déclaration régulière du nombre de quinnats remis à l'eau durant les saisons de pêche lorsque les ligneurs ne sont autorisés à garder que les sujets de taille légale. La régularité de ce biais tout au long de la période à l'étude s'est traduite par des facteurs de correction moyens de 1,33 à 1,67. Nous avons démontré la stabilité du biais de sous-déclaration à l'aide de deux approches différentes caractérisées par deux stratifications spatio-temporelles différentes (zone de gestion-année de permis et zone de gestion-semaine statistique) des ensembles de données des observateurs et des journaux de bord et deux variables statistiques différentes (proportion des prises remises à l'eau et nombre remis à l'eau par unité d'effort). Nous avons évalué une troisième variable (rapport entre le nombre remis à l'eau et le nombre gardé), mais nous l'avons considérée comme sous-optimale pour expliquer la variabilité dans les données des observateurs. Il est important de posséder la capacité de corriger la sous-déclaration du nombre de poissons remis à l'eau afin d'être en mesure d'évaluer plus efficacement les taux de mortalité accidentelle dans les pêches du saumon quinnat aux lignes traînantes; cette capacité est également essentielle à un régime de gestion de la mortalité totale selon lequel les pêcheurs sont comptables de la mortalité des sujets de taille légale et des sujets de taille inférieure à la taille légale.

INTRODUCTION

Observer programs are vital to sustainable fisheries management around the globe as a tool to implement effective fisheries monitoring, control, surveillance and law enforcement, and to promote compliance with applicable management measures (FAO 1995). Observer data are used by scientists and fisheries managers to generate status profiles of fisheries. They help identify when a fishery is being overly conservative, resulting in unnecessary cuts in fishing, or temporary or permanent closures, or conversely, not conservative enough, leading to severe overfishing and long-term detriment to entire fishing-dependent communities (PCFFA 2009). There are about 40 observer programs in Canada spread over the Atlantic and Pacific coasts and the Laurentian Great Lakes that are implemented to assist the management of pelagic fish, groundfish, shellfish, crustaceans, and anadromous salmonids (PCFFA 2009).

Although an earlier logbook/observer project was implemented in 1981-1983 to record landed catch and release information from troll fisheries in the west coast of British Columbia (Healey et al. 1985), coordinated and continuous observer and logbook/phone-in programs did not started until 1998, with the goal of monitoring commercial salmon fisheries (seine, gillnet, troll) in the Canadian Pacific south coast. Although the original objective of the programs was to minimize mortality of Coho salmon (*Oncorhynchus kisutch*) as part of a recovery plan, these monitoring programs currently are important tools to document the catch and release of all species of salmon. This information is used to minimize the by-catch of non-target species (including salmon for non-retention fishing periods) and the incidental harvest of salmon stocks of concern (Fisheries and Oceans Canada 1999, 2000, 2001). The logbook and phone-in reports are mandatory for the acquisition of fishing licenses and consequently, the current coverage of the program is essentially 100%. These reports collect catch information for retained and released salmon by species, and also compile additional information such as gear type, fishing location and time, fishing effort, and vessel name. Fisherman phone-in the data during the season and the completed logbook is mailed to Fisheries and Oceans Canada at the end of the season. Observers are placed on board of a portion of active vessels to provide a representative coverage of the fishing fleet (observer coverage is usually less than 10% of the fishing effort) and corroborate the information provided by the logbook/phone-in program. Additional applications of the Pacific salmon observer program have been (i) to provide expanded catch estimates that can be compared with the catches reported in the logbooks, (ii) to sample tissue for DNA analysis, (iii) to identify areas of unacceptably high by-catch and incidental mortality (Fisheries and Oceans Canada 1999, 2000, 2001), and (iv) to report Coho and Chinook (*O. tschawytscha*) condition at capture and release to determine short-term mortality and identify mortality trends (Fisheries and Oceans Canada 2002, 2003, 2004).

Corroborating the number of sublegal fish (smaller than the minimum size limit) encountered and released during retention periods, and sublegal and legal fish released during non-retention periods reported in logbooks is an important application of the observer program that has not been thoroughly explored. This information, when combined with estimates of post-release mortality, could help to determine more accurate

incidental mortality rates. There has been no previous attempt to apply observer data to correct for bias in the number of released fish reported in logbooks from commercial fisheries in the West Coast of Canada. Summary reports of the observer and logbook monitoring programs for commercial fisheries, implemented in the south coast of British Columbia, have compared expanded (by fishing effort and area) estimates of Chinook and Coho releases, but these data have been used only to inform managers with timely and accurate catch and effort data (Fisheries and Oceans Canada 2003, 2004). In the present paper, observer reports are used to evaluate the reliability of logbooks as a source of data on the number of released Chinook salmon in commercial troll fisheries. This is a particularly important endeavor for the management of Chinook salmon under the 2009 Pacific Salmon Treaty in which the governments of Canada and the United States of America agreed to adopt total mortality management for Chinook salmon. In the Treaty, total mortality is defined as the sum of landed catch and the associated incidental mortality (Pacific Salmon Commission 2009). As a result of this agreement, fishers will be eventually accountable for both legal and sublegal mortality. This accountability could influence the accuracy of reported Chinook releases as a result of fisher's attempt to reduce the incidental mortality rates derived from reported number of releases while increasing the opportunity for landed catch for a given allowable total fishing mortality. Moreover, underreporting of incidental mortality can be a common occurrence in commercial fisheries due to fishers' perception of the public opinion on conservation and sustainability (see Alverson et al. 1994).

The main goal of the present study is to determine the magnitude of logbook bias in the reported number of Chinook released during retention periods by troll fisheries in West Coast Vancouver Island (WCVI) using observer data as an unbiased data source. The specific objectives of this study are: (i) to determine whether there is a consistent pattern in the logbook bias of number released for the period 1998-2008 that could be used to generate correction factors; (ii) to evaluate how different spatial-temporal stratifications influence functional relationships between logbook and observer data; and, (iii) to compare the performance of various statistical metrics to generate statistically robust correction factors.

METHODS

Data used were from the period 1998-2008 as provided via queries from the Fishery Operation System (FOS), maintained by the Fisheries Management Information Services of Fisheries and Oceans Canada. Year 1998 was the first year queried because it is the first year when both observer and logbook data are reported in FOS. These data reports included information on commercial licenses for WCVI (statistical management areas 21-27 and 121-127), which encompasses most of commercial troll area G as defined in Canadian salmon fisheries (Figure 1). These statistical management areas correspond to the Pacific Management Areas (PFMA) specified in the PST for the management of Chinook salmon WCVI troll fisheries. Among the data fields included in the reports, particularly relevant for the purposes of the study were number of Chinook kept (landed catch; K), number of Chinook released (R), fishing effort (boat hours; FE), fishery

opening (retention /non-retention) identifier, legal/sublegal identifier, statistical management area, statistical week, and license year. Explaining some of these fields:

- During Chinook retention (CR) periods, trollers are allowed to retain legal-sized Chinook salmon, i.e., fork length (FL) equal or greater than the minimum size limit (55 cm FL in the last decade).
- During Chinook non-retention (CNR) periods, retention of Chinook is prohibited in fisheries targeting other species. Such regulatory closings are implemented to prevent exceeding the annual allowable catch determined by the Pacific Salmon Commission (PSC) or for domestic management purposes such as avoidance of Chinook stocks of conservation concern.
- Salmon fisheries divide the calendar year into 53 statistical weeks for management purposes.
- FOS license years represent calendar years for year 2000 and previous years, and encompass the period April 1st to March 30th for the remaining years (excepting 2001, which ran from January 1st 2001 to March 30th 2002). There is no overlap between license years defined in FOS and therefore there is no double counting of fishing events.

Statistical analyses were applied exclusively to retention periods (fisheries targeting Chinook or allowing the incidental retention of Chinook) for three reasons. First, data representing CNR periods in WCVI show discontinuities and constitute a small portion of the fishing effort allocated in the study period (~17%), thus posing difficulties to independent statistical analyses of these data. Second, working exclusively with retention periods reduces the importance of legal/sublegal stratification since the number released in retention periods essentially represents the number of sublegal Chinook released. Preliminary exploration of the database showed some legal releases in retention periods (4%) reported in FOS for the period 2004-2008. These legal releases come from two sources: legal size Chinook that are damaged (these fish are released to leave room for good quality fish) and errors in the database that occasionally can be detected comparing logbooks with phone-in reports (*personal communication*; B. Patten, Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo BC). Third, it is possible that reporting bias for the number released differs between CR and CNR fisheries due to different encounter patterns. However, inferences were made about CNR periods based on the analysis of data from CR fisheries (see Methods).

Statistical analyses

Regression analyses of statistical metrics derived from logbook and observer datasets from CR periods were used to determine magnitude and trend of potential bias in the logbook-reported number of released Chinook. These analyses were conducted using three statistical metrics for each of two stratification levels (see next section): proportion released (*PR*; equation1); number released per fishing effort (*RFE*; equation 2); and, released-kept ratio (*RK*: equation 3).

$$PR = \frac{R+1}{R+K+1} \qquad (1)$$

$$RFE = \frac{R+1}{FE} \tag{2}$$

$$RK = \frac{R+1}{K+1} \tag{3}$$

In the above equations, the added "ones" reduce sampling bias in cases where the numbers involved are small or zero (Bailey 1951). These metrics are necessary because it is inappropriate to compare directly the number released between logbooks and observers, even for fishing events taking place on the same date and location, due to variability in fishing skills, fishing technique, boat fishing capacity, and fishing effort associated to each vessel and fishing trip. The above metrics reduce the influence of these factors by taking into account the age-size structure of stocks that will influence the released-kept ratios (metrics *PR* and *RK*) and by standardizing for fishing effort (metric *RFE*), which together with abundance should be one of the main factors influencing the number released.

Various data transformations did not improve the fit of logbook-observer relationships for metrics *PR* and *RFE* and therefore regression analyses were conducted with untransformed metric values. *RK* values were $\log_e$-transformed prior to the analyses. In all cases, when linearity was not obvious, parsimonious polynomial regressions were applied.

Data stratification

Using only CR periods, two stratification scenarios were appropriate to generate adequate sample sizes. Note that sample size at all stratification levels was always smaller than the original sample size in the FOS data reports due to the application of quality filters (see next section). Statistical analyses were conducted separately for datasets stratified by statistical management area and license year (MA-LY) and for statistical management area and statistical week (MA-SW). A finer spatial stratification (e.g., troll zone) was not plausible given the common use of several troll zones by individual vessels in a single fishing trip (*personal communication*; B. Patten, Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo BC). Attempts to analyze data at such finer spatial stratification presented insurmountable challenges to pairing data strata with both logbook and observer representation.

Data stratification at the MA-LY and MA-SW levels was represented by equations 4 and 5, respectively.

$$N = \sum_{i=1}^{p} \sum_{j=1}^{q} n_{i,j} \tag{4}$$

$$N = \sum_{j=1}^{q} n_j \quad (5)$$

In the above equations N represents either R, K or FE, i represents statistical week in a management area during a given license year, p is the total number of statistical weeks fished in a management area during a given license year, j represents fishing day within a given statistical week, q is the total number of fishing days within a given statistical week, and n represents the number of Chinook released or kept or the number of fishing boat hours.

Data quality filters

Prior to the analyses, all fishing events with the presence of observers were removed from the logbook dataset because when an observer is onboard the observer data is commonly reported in the logbook. Thus, while observer coverage represents less than 10% of the annual fishing effort (excepting 1998, when observer coverage was 68% partly due to the extremely low fishing effort; Figure 2), including these fishing events would generate a perfect match between logbook and observer metrics and artificially reduce any potential reporting bias.

Only management areas and statistical weeks with observer and logbook representation (paired statistical strata) were included in the analysis to optimize observer coverage and increase the likelihood that statistical metrics were comparable between fishing events represented by logbook reports and those represented by observer reports. Matching temporal and spatial attributes between the two data sources also increases the likelihood of analyzing catch data that are biologically comparable by representing similar distribution and composition of stocks. As a result of this filter, license year 2007 was excluded from the analysis given the lack of observer coverage for CR periods in this year in WCVI.

All statistical weeks with zero encounters (no Chinook kept or released) were removed from the datasets prior to the analyses. Such data were considered uninformative while influencing the degrees of freedom and clearly added noise (outliers) to the functional relationships, thus altering fit and precision to inferences about the strata.

The above data filters were applied to both MA-LY and MA-SW stratification scenarios. In addition, statistical management areas with fishing effort of less than 40 boat hours per year of observer representation were removed from the MA-LY strata given that such low levels of observer coverage per year generate data that are unrepresentative of a given management area in a particular license year.

A limited Chinook plug fishery took place on August 2006 in area 127 off WCVI with the purpose of exploring Chinook harvest opportunities during this time period while addressing encounter constraints in stocks of concern. More specifically, this exploratory selective fishery employed large plugs designed to harvest Chinook while minimizing Coho bycatch (IFMP 2009). Although observers were placed in this

exploratory fishery, no Chinook encounters were recorded, and therefore these data were not included in the analyses.

Assumptions

Three assumptions were made for assessing potential bias in the number released reported in logbooks using observer information: (i) observer reports contain data that are unbiased; (ii) landed catch (K) reported in logbooks is a reliable number because it is verifiable; and (iii) fishing effort reported in logbooks is unbiased. Further, assumptions i and ii were required only for the MA-LY analysis, whereas the MA-SW analysis relied on assumptions i and iii.

Estimating the number released in CR fisheries

The corrected number of Chinook released in CR periods was derived from rearrangement of equations 1, 2, and 3 and regression analysis of statistical metrics as follows:

$$R_{Corrected} = \frac{f\left(PR_{Logbook}\right)\left(1+K_{Logbook}\right)-1}{1-f\left(PR_{Logbook}\right)} \tag{6}$$

$$R_{Corrected} = f(RFE_{Logbook})FE_{Logbook} - 1 \tag{7}$$

$$R_{Corrected} = f\left(RK_{Logbook}\right)K_{Logbook} + f\left(RK_{Logbook}\right) - 1 \tag{8}$$

where $f(Z_{Logbook})$ is the function determined by regression analysis (linear or polynomial) and applied to logbook metrics PR, RFE or RK to predict unbiased (observer) values.

The corrected annual number of Chinook released ($R_{Corrected}$) generated by metrics producing statistically significant regressions was compared at the two stratification levels using only those statistical management areas with more than 40 boat hours per year. Otherwise, the estimated number of Chinook released derived from RFE would include more management areas than the releases derived from PR due to the data quality filters applied (see corresponding section above).

Inferring the number released in CNR periods

For reasons explained earlier, all the previous analyses centered on Chinook retention (CR) fisheries, where the number of fish kept represents exclusively legal-size fish, which is equivalent to the landed catch, and where the number of fish released represents essentially sublegal-size fish. However, it is important for the analysis of total mortality to correct for underreporting bias in non-retention (CNR) fisheries as well. Assuming that underreporting biases are similar between CR and CNR fisheries, CR correction factors were used to estimate the corrected number of sublegal fish released in CNR periods.

This required separating legal and sublegal releases from CNR periods. Since reporting the distinction between legal and sublegal encounters in FOS started in 2004, the number of sublegal Chinook released in previous years was inferred from the average proportion of sublegal fish in CR fisheries during the study period. This was considered a reasonable procedure given a strong and significant relationship between Chinook kept (legal) and released (sublegal) detected in CR fisheries during the study period (Figure 3). Thus, assuming that the uncorrected average proportion of sublegal encounters (mean = 0.185; 95% CI = 0.144 - 0.225) is similar between CR and CNR periods, the corrected number of sublegal releases was estimated from the number of encounters (kept plus released) in CNR fisheries for years 1998-2003. As in the analysis of CR fisheries, logbook data where observers were present were avoided.

RESULTS

The relationship between logbook and observer metrics at the MA-LY stratification level was better represented by a second-order polynomial of *PR* values (Figure 4; equation 9) ($n = 25$; $R^2 = 0.90$), whereas the relationship between logbook and observer metrics at the MA-SW stratification level was better represented by a linear regression of *RFE* values (Figure 5; equation 10) ($n = 94$; $R^2 = 0.74$). Intercepts were not significantly different from zero and therefore were not included in regressions to avoid the generation of negative metric values at abscise values close to zero. Regression fit for the third metric, released-kept ratio (*RK*), was low relative to *PR* or *RFE* (Figure 4; Figure 5) and therefore was not considered for the remaining analyses.

$$f\left(PR_{Logbook}\right) = 1.3039\left(\pm 0.2695\right)\left(PR_{Logbook}\right) - 0.2816\left(\pm 0.35\right)\left(PR_{Logbook}\right)^2 \qquad (9)$$

$$f\left(RFE_{Logbook}\right) = 1.6710\left(\pm 0.1616\right)\left(RFE_{Logbook}\right) \qquad (10)$$

Equations 9 and 10 show in parentheses the regression coefficients' 95% confidence limits. The use of the *PR* metric to describe the logbook-observer relationship at the management area-license year (MA-LY) stratification level is henceforth referred as the "PR Method" whereas the use of the *RFE* metric at the management area-statistical week (MA-SW) level is referred as the "RFE Method".

The mean ratio of estimated annual number of Chinook released ($R_{Corrected}$) to the annual number derived from logbooks showed no apparent trend for the study period (1998-2008) either using the PR Method or the RFE Method (Figure 6). This lack of trend can be translated into correction factors of 1.33 (CV: 0.02) and 1.67 (CV: 0.06) for the PR and RFE methods, respectively. The 95% CI for the correction factor derived from the PR Method decreased with license year during the first half of the time series whereas the 95% CI was stable for correction factors produced by the RFE Method (Figure 6). One-way analysis of covariance (using license year as covariate) showed the correction factors generated by the PR and RFE methods are significantly different (F =

113.28; $p < 0.0001$). However, the comparison of the annual number of Chinook released derived from the PR and RFE methods revealed that the overlap between the 95% confidence intervals produced by the two methods is strong enough to allow for statistically significant differences (one-way ANCOVA using license year as covariate: $F = 1.53$; $p = 0.221$). Excepting 1998, in which Chinook encounters were extremely small due to short and limited number of retention periods, the number released in paired statistical strata ranged from 2 207 to 11 060 according to logbooks, it ranged from 2 893 (95% CI: 2 203-3 610) to 14 542 (95% CI: 10 790-18 529) according to the PR Method, and from 3 691 (95% CI: 3 334-4050) to 18 489 (95% CI: 16 699-20 278) according to the RFE Method (Figure 7). The mean of the annual number released produced by the RFE Method was always greater than the mean values produced by the PR method partly because of its linear relationship between logbook and observer metrics; the PR Method relationship, on the other hand, is convex. This produces greater observer values in the RFE Method when the logbook metric is high than in the PR Method in which the rate of change in observer's metric declines at high logbook values.

It is inappropriate to apply model selection techniques to determine which method is a better prediction tool for the number of Chinook released because there is not a historical time series to directly compare model-corrected releases. On the one hand, using the logbook data to assess model performance is unsuitable because numbers released in logbooks are biased low. On the other hand, using observer data is also inappropriate because, as mentioned before, number released as reported by observers cannot be directly expanded to logbook fishing events (even those taking place at the same temporal and spatial strata), due to variability in fishing skills, fishing technique, boat fishing capacity, and fishing effort associated to each vessel and fishing trip. Nonetheless, there are several reasons to recommend the use of the RFE Method over the PR Method to estimate the number of sublegal Chinook released during retention periods:

- Although the PR Method uses a regression equation (equation 9) with a R^2 greater than the RFE Method (equation 10) the latter exhibits greater precision (smaller confidence intervals) that translate into more precise estimates of the annual number released (Figure 7).
- The magnitude of variation in correction factors produced by the PR Method has changed through time while variation in correction factors produced by the RFE Method was stable across the study period (Figure 6).
- The RFE Method can be used for Pacific Salmon Treaty (PST) reporting and Chinook Technical Committee (CTC) model analyses because it uses statistical week as temporal stratum. This eliminates the importance of year type to derive annual estimates of the number released; whereas current FOS license years encompass the period April 1st to March 30th, calendar years or accounting years (October 1st to September 30th) are commonly used in fisheries models used by the CTC.
- The RFE Method uses more available information than the PR Method given the latter's requirement for additional data filters.
- Estimates of the number released at the finest possible spatial and temporal resolution are highly desirable.

- Using risk-averse estimates of the number of Chinook released is consistent with a precautionary approach in which underestimation of incidental mortality should be avoided.

Expanding the number released

Using the RFE Method, the corrected number of Chinook released in retention fisheries reported in logbooks was expanded to all statistical weeks and management areas assuming the estimated correction factor found in paired statistical strata is applicable to all strata in WCVI for the period 1998-2008 (Table 1). This expansion did not correct those fishing events in which observers were present because when an observer is onboard the observer data is reported in the logbook. In addition, this expansion included the number released as reported by observers in fishing events without corresponding logbooks (see Appendix). This approach produced annual numbers of Chinook released that ranged from 2 077 (95% CI: 1 891 - 2 264) in license year 1998 to 24 180 in license year 2003 (95% CI: 21 920 - 26 444) (Figure 8). An interesting attribute of the Chinook encounter rates for the study period is a clear decline in the released-kept ratio between 2000 and 2002 and a stabilization of this ratio at 10-20% in more recent years (Figure 8). A detailed summary of raw and corrected released values expanded to all statistical weeks and management areas with Chinook encounters is presented in the Appendix.

At the management area level, greater proportions (i.e., relative to the total number of encounters occurring in a management area) of Chinook salmon were released in area 127 in 1998, area 23 during 1999-2001, area 27 in 2002 (excluding area 25 with one encounter), area 24 in 2003, area 27 during 2004-2006, and in area 25 during 2007-2008 (Table 1). This shows open-ocean troll fisheries in WCVI (see Figure 1) always released lower proportions of Chinook than coastal and inner areas, simply indicating greater proportions of sublegal fish and more sublegal encounters in coastal and inside areas during retention periods. This pattern may be partly related to the distribution of Chinook juveniles, which remain relatively close to their natal stream until their second year at sea, irrespective of their freshwater history and adult run timing (Trudel et al. 2009). However, in terms of the annual number of Chinook salmon released in WCVI, open-ocean troll fisheries encountered and released greater numbers than coastal and inner fisheries (Figure 9), with most sublegal releases occurring in area 123 followed by areas 126 and 125. Among the coastal-inner areas, only area 23 (Barkley Sound) exhibited an important contribution to the total number of Chinook salmon released by troll fisheries.

Applying CR correction factors to CNR fisheries

Chinook non-retention (CNR) fisheries during the study period occurred only in years 2001, 2002, 2003, and 2006 (Table 2). These fisheries took place in statistical weeks 07/3, 07/4, 07/5, and 08/1 in 2001, 07/4 and 07/5 in 2002, 09/1 and 09/2 in 2003, and 07/5 and 08/1 in 2006 and they never overlapped with CR fisheries. Expanding the correction of number of sublegal releases to CNR fisheries through the application of the RFE Method increased the total annual releases, relative to when corrections are applied exclusively to CR fisheries, by 7% in 2001, 11% in 2002, 0.5% in 2003, and 9% in 2006. In terms of absolute numbers, the greatest contribution of sublegal releases in CNR

fisheries occurred in 2002 (1 882 – 2 286 fish) as a result of large sublegal encounters in areas 123-127 (Table 2).

DISCUSSION

The need for accurate release information has become increasingly important with the Pacific Salmon Treaty now requiring both Canada and the United States of America to provide estimates of total mortality for Chinook salmon in commercial and sport fisheries. The number of Chinook released is essential to estimate incidental mortality by the Chinook Technical Committee of the PSC, where incidental mortality is computed as the product of assumed post-release mortality rate and estimated number of Chinook released (TCCHINOOK 2004). Inaccurate release information could have significant impacts on Chinook stocks since management actions based on these data may not meet the precautionary approach required to avoid overexploitation. In the present study, it has been demonstrated there is a bias in logbook-reported Chinook released during retention periods in WCVI that is consistent across the last decade. The stability of this bias was demonstrated with two different approaches, generating average correction factors of 1.33 and 1.67 with the PR and RFE methods, respectively. The main causes of this difference in correction factors are the larger number of measurements (more statistical weeks) used by the RFE Method and the linear nature of the regression between logbook and observer *RFE* metrics. Given RFE's greater accuracy, finer temporal scale, and risk-averse estimates of number released, we recommend using this method to adjust for logbook underreporting of Chinook released in the WCVI troll fishery.

Further investigation is needed to assess the magnitude of potential underestimates of Chinook released in other areas and time periods and from other fisheries (e.g., sport, net). There is no observer data that can be used to similarly correct logbook data from troll fisheries in the north coast of British Columbia (NBC) or Southeast Alaska (SEAK). Extending the correction factor(s) reported in the present study to NBC fisheries could be a precautionary measure until future studies provide new reliable information but this idea is suspect considering the differences in minimum size limits and fisheries dynamics between WCVI and NBC that likely translate into different encounter rates (*personal communication*; R. McNicol, Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo BC). This difference in encounter rates is supported by the lower proportions of sublegal incidental mortalities during Chinook retention troll fisheries reported in NBC versus the WCVI (see TCCHINOOK 2009).

The approach followed in the present study cannot be applied using information collected by the Alaska Department of Fish and Game (ADFG) because logbooks from troll fisheries in SEAK are voluntary. An observer-logbook program implemented by the ADFG with a coverage of 1.7%, 4.0%, and 6.2% of the fishing effort in 1998, 1999, and 2000, respectively, found no significant differences between logbook and observer estimates for sublegal Chinook during retention periods in Southeast Alaska (Stopha et al. 2000, Bloomquist and Carlile 2001). However, the low logbook coverage in SEAK constitutes an important difference with Canada, where the logbook program covered

75% of the fishing effort in troll fisheries at the beginning of the program in 1998 (Fisheries and Oceans Canada 1999) and currently is essentially 100% due to mandatory fishing license conditions (Fisheries and Oceans Canada 2004).

Similar to our findings in Chinook-directed troll fisheries, Diewert et al. (2005) found consistently higher estimated releases of Chinook and Coho salmon in Georgia Strait based on independent observer data in sport fisheries relative to data provided by creel surveys. Although the independent observer program was implemented only for three months (July-September) in 1998, Diewert et al.'s (2005) results suggested that a bias may exist in the creel survey resulting in an underestimate of the number released by recreational anglers. The magnitude of the underreporting bias can be translated into correction factors of 2.1 for Chinook and 2.3 for Coho. Further, a comparison of observer and logbook expanded estimates of Chinook released derived from the monitoring programs for south coast commercial salmon fisheries implemented by Fisheries and Oceans Canada showed the number of Chinook released estimated from observer information was 1.29 (year 2003) and 1.49 (year 2002) times greater than the estimate derived from logbook data (Fisheries and Oceans Canada 2003, 2004). Although the analyses contained in the summary reports of the south coast monitoring program for license years 2002 and 2003 cannot be used to generate correction factors, the south coast studies interestingly found that observer estimates of non-target species (including sublegal fish) are typically higher than the logbook estimate while logbook estimates for target species are similar to observer estimates (Fisheries and Oceans Canada 2003, 2004). This underreporting of encounters and releases of non-target and sublegal fish is consistent with fisher awareness of the implications non-target-and sublegal mortality on their total allowable catches and possibly on the public opinion.

The full implementation of a total mortality management regime for Chinook salmon could change the bias in the number released identified in the present study. Increased fisher awareness of the accountability that sublegal mortality has on total allowable catch is expected to accrue underreporting levels with the expectation of maximizing landed catch by minimizing incidental mortality. This possibility of a greater underreporting of the numbers released in troll logbooks supports the continuance of the observer program in British Columbia. Increasing observer coverage is also advisable to provide high quality data allowing for robust statistical analyses. Our current perception is that there are no shortcuts to the identification and quantification of underreporting biases. All of the statistical metrics used in this investigation require the number of Chinook released reported in logbooks to derive correction factors. Thus, an independent source of catch and release data such as the one provided by the observer program seems to be irreplaceable to monitor fishing dynamics and potential changes in reporting biases. Moreover, the continuation of the logbook-observer program would provide the basis for the reexamination of correction factors, especially if the observer coverage responds to effective survey designs addressing the increase of statistical power and temporal and spatial representation.

It is apparent that underreporting of the number of fish released in commercial and sport Chinook fisheries can be a common occurrence. Finding ways of assessing this

bias and correcting the number released is important not only to account more accurately for incidental mortality associated to troll fisheries in Chinook salmon but also to improve estimates of incidental mortality related to commercial and sport Pacific salmon fisheries in general. It is advisable to continue compiling catch and effort data for non-retention fisheries in order to enrich time series and facilitate analyses of underreporting biases when the retention of legal fish is not allowed. The *RFE* metric could be used for this purpose since it does not require the number of fish kept. Further, although in the present paper it was assumed that correction factors derived from the analysis of CR data could be applied to CNR periods, underreporting bias could be greater for CNR periods in response to fishers' attempt to minimize the detrimental effect by-catch mortality has on annual allowable catches. And since the economic benefit of landing the catch of legal-size fish does not exist in CNR periods, the underreporting of released fish could be exacerbated.

Finally, correction factors identified and quantified in the present paper can be used to adjust the numbers of sublegal Chinook released in troll fisheries in British Columbia for the period 1998-2008 and recalculate estimates of incidental mortality used by the Chinook Technical Committee (TCCHINOOK 2004) to guide management approaches and implement the PSC Chinook rebuilding program. Nonetheless, the use of these corrections within a PST total mortality regime would be contingent on the development of similar analyses for NBC and SEAK troll fisheries. In addition, other sources of uncertainty remain, thus requiring additional attention: (i) bias in post-release mortality rates; (ii) impact of changes in minimum size limits; and, (iii) bias in the number of legal fish released in CNR fisheries.

Post release mortalities rates used by the PSC Chinook Technical Committee to estimate incidental mortalities in WCVI troll fisheries (18.5% for legal fish and 22.0% for sublegal fish) have remained constant since 1997 (TCCHINOOK 1997) and the detection of bias in these rates would require additional studies. The use of higher troll hooking mortality rates for sublegal Chinook salmon respond to research showing on average 1.15 times higher mortality in sublegal Chinook than in legal Chinook (Wertheimer et al. 1989, NRC 1996). Other mortality rates used in the computation of incidental mortality are the drop-off mortality rates, which pertain to those fish that escape being brought to the boat but die as a result of the encounter with the fishing gear (TCCHINOOK 2004). Potential bias in drop-off mortality rates would also influence the accuracy of estimated incidental mortalities.

With the exception of 1998 when the minimum size limit for troll fisheries in WCVI was 45 cm FL, minimum size limit has remained constant at 55 cm FL in all other years of the study period. However, future changes in size limits are expected to affect the proportion of fish stocks vulnerable to fishing and therefore the relationship between legal and sublegal releases. Since incidental mortality caused by the encounter and release of sublegal fish is directly proportional to minimum size limit, decreasing the minimum size limit is expected to reduce bias in the number released whereas increasing the size limit is expected to increase the bias. Additional studies and continuous

monitoring would be required to detect changes in correction factors associated to misreporting of released Chinook salmon in troll fisheries.

The present study did not cover the detection and/or quantification of bias in the number of legal Chinook released during non-retention periods. Akin to sublegal releases in non-retention fisheries, the continuous record of legal releases and fishing effort during CNR fisheries would be required to provide sample sizes large enough for sound and robust statistical analyses. Observers systematically placed in CNR fishing events would be necessary to address this matter.

ACKNOWLEDGEMENTS

The authors wish to thank all the members of the Total Mortality Workgroup of the PSC Chinook Technical Committee for their comments and suggestions. We also thank L. Hop Wo for providing us with relevant information about the observer program and B. Patten and R. Houtman for their valuable help to extract data reports from FOS and their insightful comments.

REFERENCES

Alverson, D.L., Freeberg, M.H., Pope, J.G., and Murawski, S.A. 1994. A globalassessment of fisheries bycatch and discards. FAO Fisheries Technical Paper No. 339, Rome. 233 p.

Bailey, N.T.J. 1951. On estimating the size of mobile populations from capture-recapture data. Biometrika 38:293-306.

Bloomquist, R., and Carlile, J. 2001. The 2000 Southeast Alaska troll observer programstudy. Regional Information Report No. 1J01-32, Southeast Region, Division of Commercial Fisheries, Alaska Department of Fish and Game, Juneau, Alaska. 28 p.

Diewert, R.R., Nagtegaal, D,A., and Hein, K. 2005. A comparison of the results of the 1998 Georgia Strait creel survey with an independent observer program. Can. Manuscr. Rep. Fish. Aquat. Sci. 2716: vii + 39 p.

FAO. 1995. Code of conduct for responsible fisheries. Food and Agriculture Organization of the United Nations, Rome. 41 p.

Fisheries and Oceans Canada. 1999. Summary report: observer and logbook monitoring programs for South Coast commercial salmon fisheries, 1998. Prep. By Fishery Management Group and A.Y. Fedorenko, B.C. 21 p.

Fisheries and Oceans Canada. 2000. Summary report: observer and logbook monitoring programs for South Coast commercial salmon fisheries, 1999. Prep. By Fishery Management Group, B.C. 24 p.

Fisheries and Oceans Canada. 2001. 2000 Summary report: observer and logbook monitoring programs for South Coast commercial salmon fisheries. Prep. By Fishery Management Group, B.C. 24 p.

Fisheries and Oceans Canada. 2002. 2001 Summary report: Southern BC salmon catch monitoring programs. Observer, logbook and First Nations catch reports. Prep. By Catch Monitoring Group, B.C. 18 p.

Fisheries and Oceans Canada. 2003. 2002 Summary report: Southern BC salmon catch monitoring programs. Observer, logbook and First Nations catch reports. Prep. By Stock Assessment, Catch Monitoring Group, B.C. 20 p.

Fisheries and Oceans Canada. 2004. 2003 Summary report: Southern BC salmon catch monitoring programs. Observer, logbook and First Nations catch reports. Prep. By Stock Assessment, Catch Monitoring Group, B.C. 18 p.

Healey, M.C., Riddell, B., Jordan, F.P., and Morris, J. 1985. The 1981-1983 west coast troll logbook project: 1. Outline of the project and data on catch of Chinook (*Oncorhynchus tshawytscha*) and Coho (*O. kisutch*) salmon. Ca. Data Rep. Fish. Aquat. Sci. 546.

IFMP. 2009. 2008/2009 Integrated Fisheries Management Plan Salmon Southern B.C. Fisheries and Oceans Canada, Pacific Region. 203 p.

NRC. 1996. Draft final report on 1995 NEAP at-sea research projects. Natural Resource Consultants, Seattle, Washington.

Pacific Salmon Commission. 2009. Treaty between the government of Canada and the government of the United States of America concerning pacific salmon. Vancouver, B.C. Last updated: January, 2009. 152 p.

PSCFFA. 2009. Fisheries observer programs. The Pacific Coast Federation of Fishermen's Association. http://www.pcffa.org/obs.htm (last visit: July 2009).

Stopha, M., Bloomquist, R., and Carlile, J. 2000. The 1999 Southeast Alaska troll observer program study. Regional Information Report No. 1J00-11, Southeast Region, Division of Commercial Fisheries, Alaska Department of Fish and Game, Juneau, Alaska. 27 p.

TCCHINOOK. 1997. Incidental fishing mortality of chinook salmon: mortality rates applicable to Pacific Salmon Commission fisheries. Pacific Salmon Commission Report TCCHINOOK (97)-1. Vancouver, British Columbia.

TCCHINOOK. 2004. Estimation and application of incidental fishing mortality in Chinook salmon management under the 1999 agreement to the Pacific Salmon Treaty. Report TCCHINOOK (04)-1, Pacific Salmon Commission Joint Chinook Technical Committee Report.

TCCHINOOK. 2009. 2009 Annual report of catches and escapements. ReportTCCHINOOK (09)-1, Pacific Salmon Commission Joint Chinook Technical Committee Report.

Trudel, M., Fisher, J., Orsi, J.A., Morris, J.F.T., Thiess, M.E., Sweeting, R.M., Hinton, S., Fergusson, E.A., Farley, E.V., and Welch, D.W. 2009. Distribution and migration of juvenile salmon derived from coded-wire tag recoveries along the continental shelf of western North America. Trans. Am. Fish. Soc. 138, DOI: 10.1577/T08-181.1

Wertheimer, A.C., Celewycz, A., Mortensen, D.G., Jaenicke, H.W., and Orsi, J.A. 1989. Size-related hooking mortality of incidentally caught Chinook salmon. Marine Fisheries Review 5(2): 28-35.

Table 1. Chinook kept and released and fishing effort (FE; boat hrs) per license year and management area as reported in logbooks from retention periods (CR), and expanded number released using correction factors generated by the RFE Method. Low and High corrected number released represent the 95% CL. The expanded number does not correct those fishing events in which observers were present, as observer data are generally identical to logbook data. In such cases the observer data is used and estimation is not required (see Appendix).

License year	Manage. area	Logbook Kept	Logbook Released	Logbook FE	CR corrected released		
					Low	Mean	High
1998	23	19	64	612	201	208	215
1998	123	1999	750	300	1132	1253	1374
1998	124	43	84	66	127	141	154
1998	125	940	138	208	209	230	252
1998	126	901	86	225.5	130	143	157
1998	127	9	61	28	92	102	112
Total 1998		3911	1183	1439.5	1891	2077	2264
1999	23	158	230	2695.5	323	352	382
1999	123	18602	5734	3866.6	8399	9244	10090
1999	124	508	43	63	65	72	79
1999	125	7662	2530	1644.7	3695	4065	4435
1999	126	4606	1212	1039.4	1805	1995	2184
1999	127	256	90	179.5	136	150	166
Total 1999		31792	9839	9488.7	14423	15878	17336
2000	23	12	68	1226.25	98	107	117
2000	123	3567	2053	1424.75	2904	3175	3446
2000	124	125	77	123	116	129	141
2000	125	3983	1069	1256	1571	1730	1889
2000	126	8688	2265	2634.25	3363	3711	4058
2000	127	640	434	210	606	660	716
Total 2000		17015	5966	6874.25	8658	9512	10367
2001	23	2535	995	3220.3	1504	1662	1822
2001	123	41236	8774	12924	12857	14154	15447
2001	124	1717	72	1369.5	108	118	132
2001	125	410	103	111.5	155	172	189
2001	126	2056	271	393.5	395	434	473
Total 2001		47954	10215	18018.8	15019	16540	18063
2002	23	3597	1339	5477.8	2023	2237	2454
2002	25	0	1	2	2	2	2
2002	27	32	17	42.5	26	29	31
2002	123	77590	7393	14871.1	10900	12015	13126
2002	124	9376	1215	3381.5	1828	2022	2217
2002	125	3253	130	1686	198	216	238

2002	126	26390	1439	8777.8	2164	2392	2622
2002	127	3726	216	1668.5	326	361	396
Total 2002		123964	11750	35907.2	17467	19274	21086
2003	23	3503	846	2016.75	1277	1415	1549
2003	24	30	29	19.5	44	48	53
2003	25	68	2	26	3	3	4
2003	26	417	26	133	41	43	48
2003	27	642	89	236.25	136	147	163
2003	123	79479	8298	14753.8	12224	13469	14714
2003	124	1247	88	637.5	135	150	160
2003	125	2220	132	596	200	220	242
2003	126	48979	4684	15932	7002	7736	8473
2003	127	5705	567	2028	858	949	1038
Total 2003		142290	14761	36378.8	21920	24180	26444
2004	23	4339	637	1563.25	963	1065	1166
2004	25	187	31	111	48	51	57
2004	26	1067	34	190	53	57	62
2004	27	10	9	11	14	15	16
2004	123	49130	5032	6781	7563	8362	9165
2004	124	9480	585	1645	876	968	1061
2004	125	12697	659	3920	999	1098	1206
2004	126	60511	2689	16974.3	4039	4467	4894
2004	127	10444	624	2554	944	1042	1142
Total 2004		147865	10300	33749.5	15499	17125	18769
2005	23	1732	313	1502.5	474	523	572
2005	24	186	16	161	24	26	30
2005	25	116	7	76.5	11	12	12
2005	26	30	2	10	3	3	4
2005	27	2	3	11.5	5	5	5
2005	123	25786	2807	5921.5	4198	4635	5077
2005	124	5912	467	2664	706	780	855
2005	125	11712	549	3846	829	916	1003
2005	126	56704	2466	22636	3715	4110	4504
2005	127	7005	780	3238	1178	1304	1428
Total 2005		109185	7410	40067	11143	12314	13490
2006	23	2454	742	1563.5	1122	1240	1359
2006	24	147	5	145	8	8	9
2006	25	148	37	101.5	56	61	69
2006	26	20	6	4	9	10	11
2006	27	70	83	90	127	140	152
2006	123	49390	4567	10807	6799	7506	8211
2006	124	2035	199	816.5	303	331	364
2006	125	13507	1222	5430.5	1841	2033	2229
2006	126	22755	1398	11542	2110	2337	2563
2006	127	7872	232	4669.48	352	388	424
Total 2006		98398	8491	35169.5	12727	14054	15391
2007	23	1379	285	906	432	475	521
2007	24	133	7	101	11	12	13

2007	25	11	9	16	14	15	16
2007	26	7	0	9	0	0	0
2007	27	17	3	14	5	5	5
2007	123	31731	4631	13412.5	6989	7736	8485
2007	124	4914	191	2520	291	320	349
2007	125	4854	325	2127.5	494	543	594
2007	126	8641	428	6321	648	716	783
2007	127	7229	339	5485	513	568	622
Total 2007		58916	6218	30912	9397	10390	11388
2008	23	671	121	671	184	202	220
2008	24	17	0	76	0	0	0
2008	25	155	80	131	121	133	146
2008	27	55	6	117	10	10	11
2008	123	54591	4649	13263.3	6966	7698	8432
2008	124	2614	123	2281.5	187	204	227
2008	125	820	68	972.5	105	115	126
2008	126	9065	525	6949.5	792	875	965
2008	127	4636	203	5207.5	310	340	374
Total 2008		72624	5775	29669.3	8675	9577	10501

Table 2. Corrected number of Chinook salmon in retention (CR) and non-retention (CNR) troll fisheries for years within the study period (1998-2008) with CNR fisheries. The last three columns represent the sum of these two components.

License	Manage.	CR corrected released			CNR corrected released			Total corrected released		
year	area	Low	Mean	High	Low	Mean	High	Low	Mean	High
2001	23	1504	1662	1822				1504	1662	1822
2001	121				24	27	29	24	27	29
2001	123	12857	14154	15447	1005	1113	1221	13862	15267	16668
2001	124	108	118	132	17	18	20	125	136	152
2001	125	155	172	189	26	28	31	181	200	220
2001	126	395	434	473	6	7	7	401	441	480
2001	127				12	13	15	12	13	15
Total 2001		15019	16540	18063	1078	1193	1308	16097	17733	19371
2002	23	2023	2237	2454	3	3	4	2026	2240	2458
2002	25	2	2	2				2	2	2
2002	27	26	29	31				26	29	31
2002	123	10900	12015	13126	267	296	324	11167	12311	13450
2002	124	1828	2022	2217	919	1018	1116	2747	3040	3333
2002	125	198	216	238	109	120	132	307	336	370
2002	126	2164	2392	2622	382	423	464	2546	2815	3086
2002	127	326	361	396	202	224	246	528	585	642
Total 2002		17467	19274	21086	1882	2084	2286	19349	21358	23372
2003	23	1277	1415	1549				1277	1415	1549
2003	24	44	48	53				44	48	53
2003	25	3	3	4				3	3	4
2003	26	41	43	48				41	43	48
2003	27	136	147	163				136	147	163
2003	123	12224	13469	14714	45	50	55	12269	13519	14769
2003	124	135	150	160	63	70	77	198	220	237
2003	125	200	220	242				205	225	247
2003	126	7002	7736	8473				7002	7736	8473
2003	127	858	949	1038	5	5	5	863	954	1043
Total 2003		21920	24180	26444	113	125	137	22038	24310	26586
2006	23	1122	1240	1359				1122	1240	1359
2006	24	8	8	9				8	8	9
2006	25	56	61	69				56	61	69
2006	26	9	10	11				9	10	11
2006	27	127	140	152				127	140	152
2006	123	6799	7506	8211	207	229	251	7006	7735	8462
2006	124	303	331	364	658	729	799	961	1060	1163
2006	125	1841	2033	2229	140	155	170	1981	2188	2399
2006	126	2110	2337	2563	5	5	5	2115	2342	2568
2006	127	352	388	424	86	95	104	438	483	528
Total 2006		12727	14054	15391	1096	1213	1329	13823	15267	16720

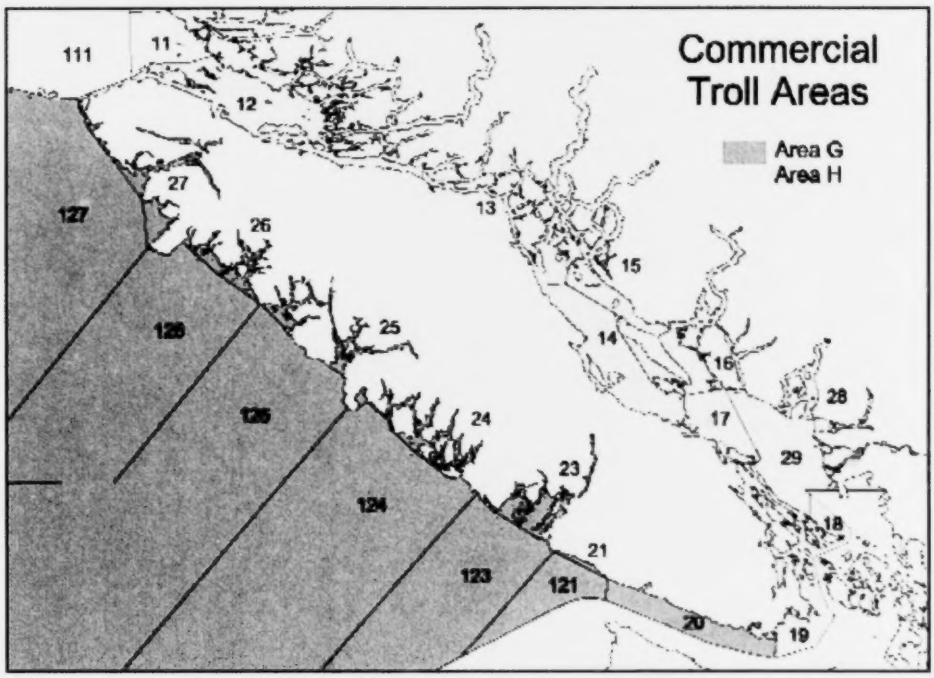

Figure 1. License Areas (G, H) and statistical management areas (numbers) for commercial troll fisheries in the South Coast of British Columbia. Pacific Management Areas (PFMA) specified in the PST for the management of Chinook salmon fisheries in West Coast Vancouver Island (WCVI) correspond with management areas within License area G, excepting Area 20 in Juan de Fuca Strait.

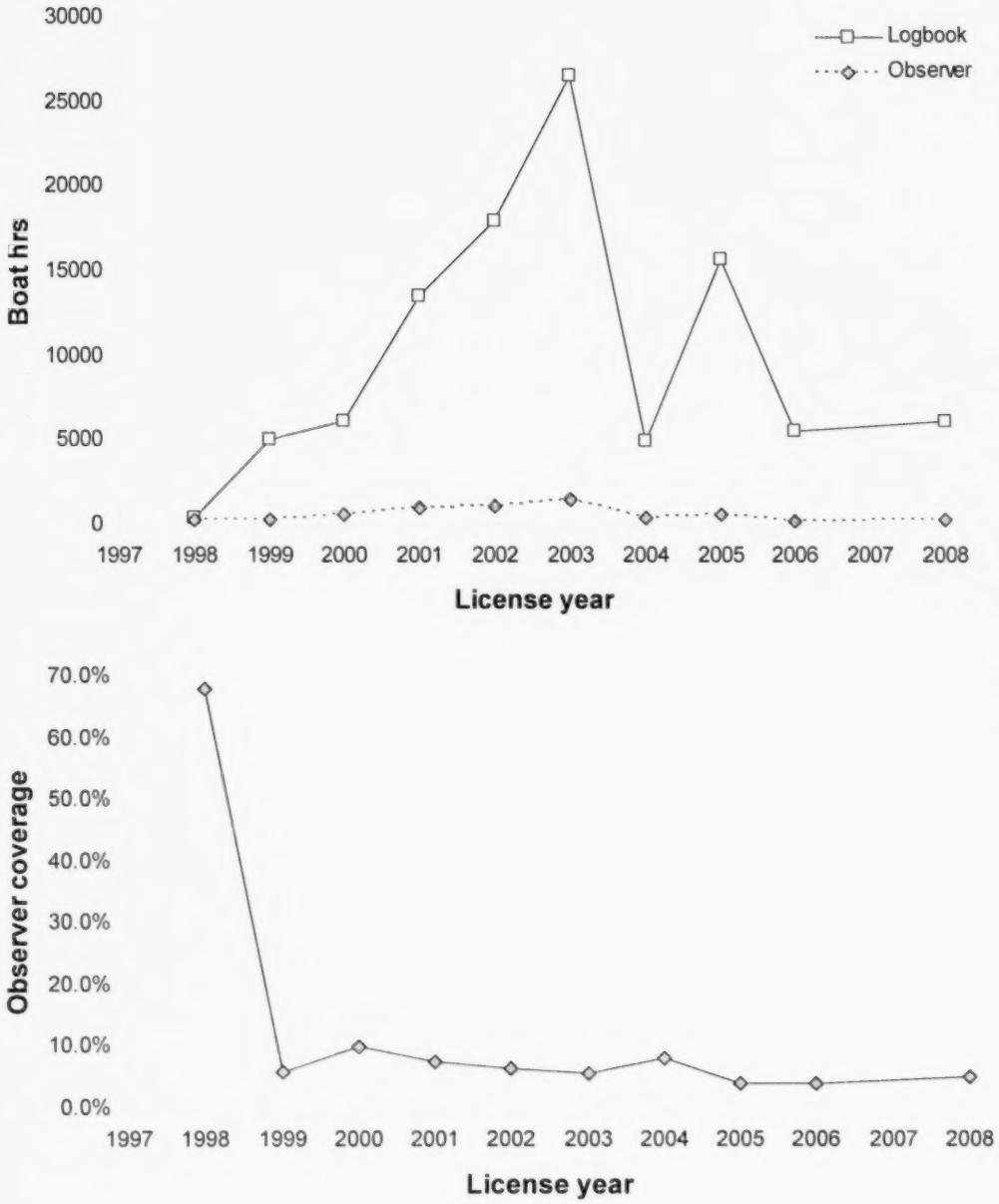

Figure 2. Fishing effort (boat hrs) reported in logbooks and covered by observers (upper panel) and fishing-effort observer coverage (lower panel) for license years 1998-2008 in WCVI. Observer coverage represents only management areas and statistical weeks with both observer and logbook representation (paired statistical strata).

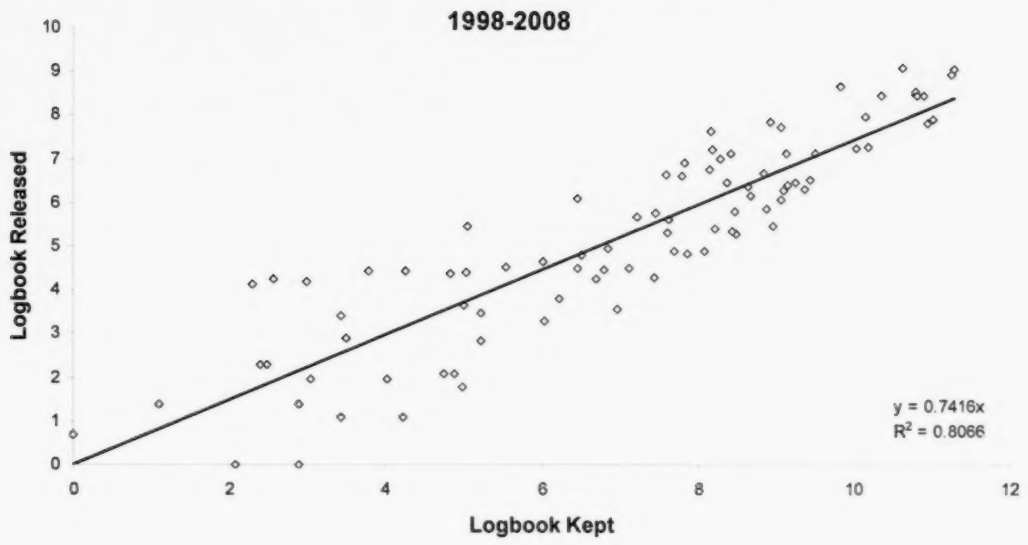

Figure 3. The relationship between the numbers of Chinook salmon kept and released in troll fisheries in WCVI for the 1998-2008 period. Each point represents a management area in a particular license year. Values are $\log_e$-transformed.

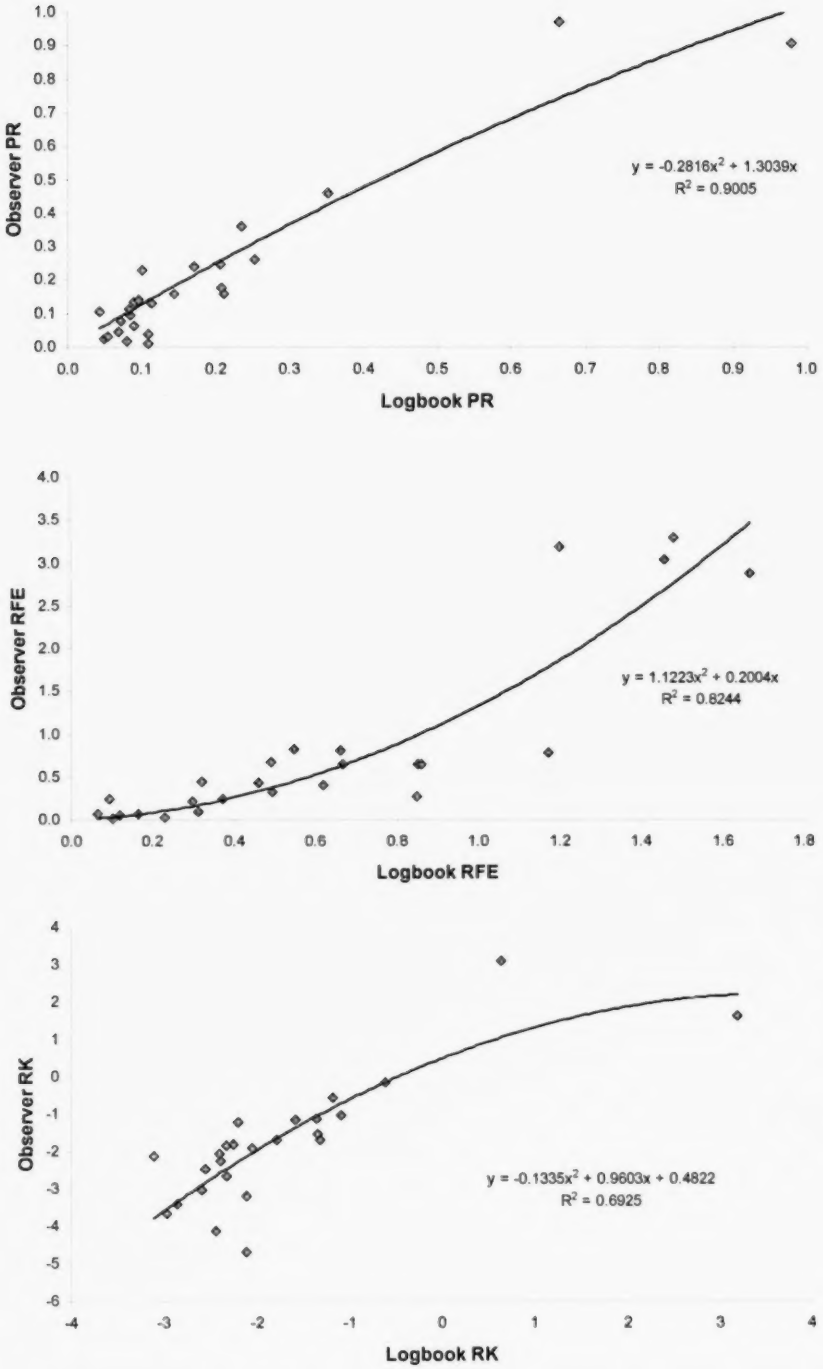

Figure 4. Relationships between logbook and observer statistical metrics at the MA-LY stratification level from troll fisheries in WCVI for the period 1998-2008.

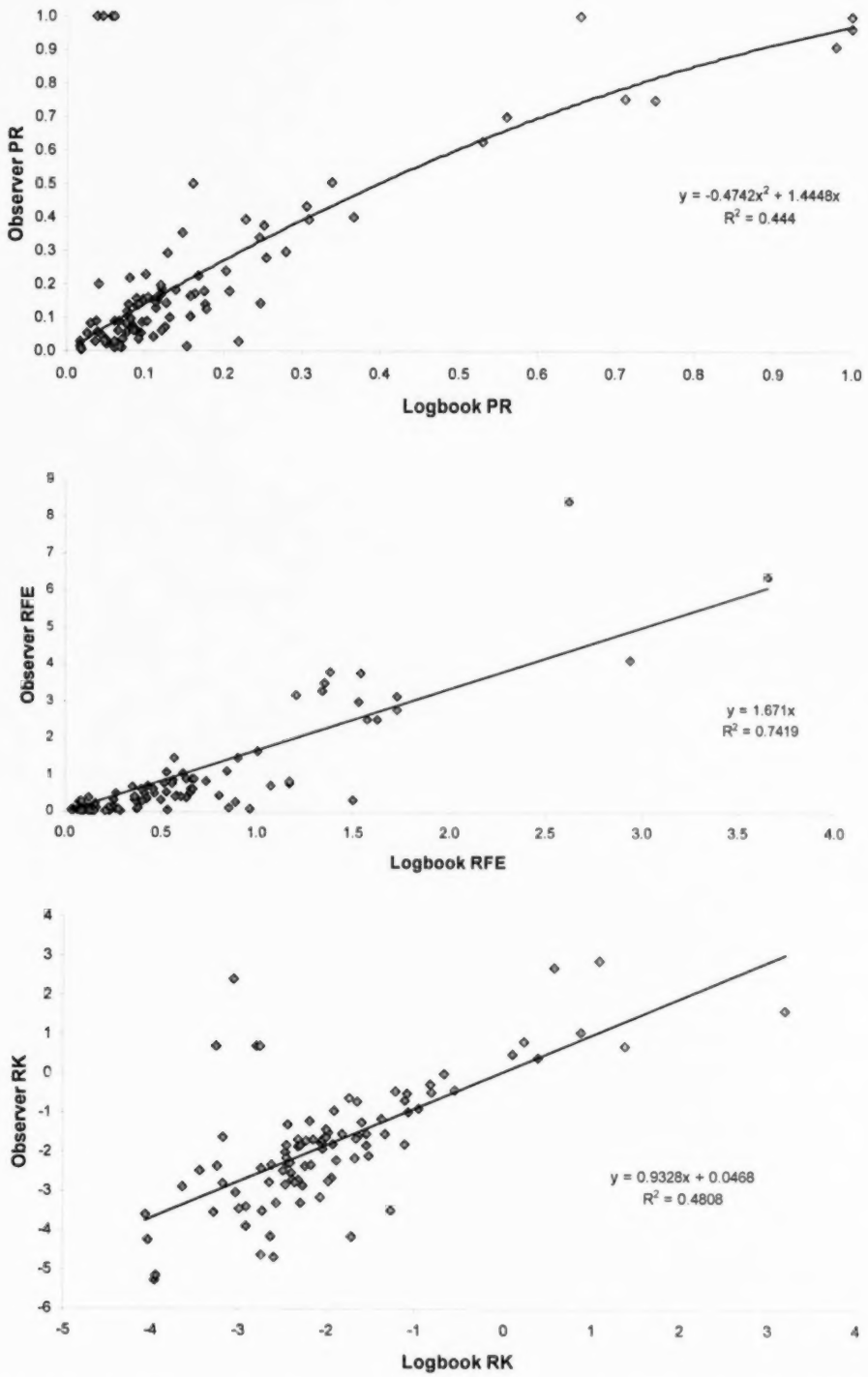

Figure 5. Relationships between logbook and observer statistical metrics at the MA-SW stratification level from troll fisheries in WCVI for the period 1998-2008.

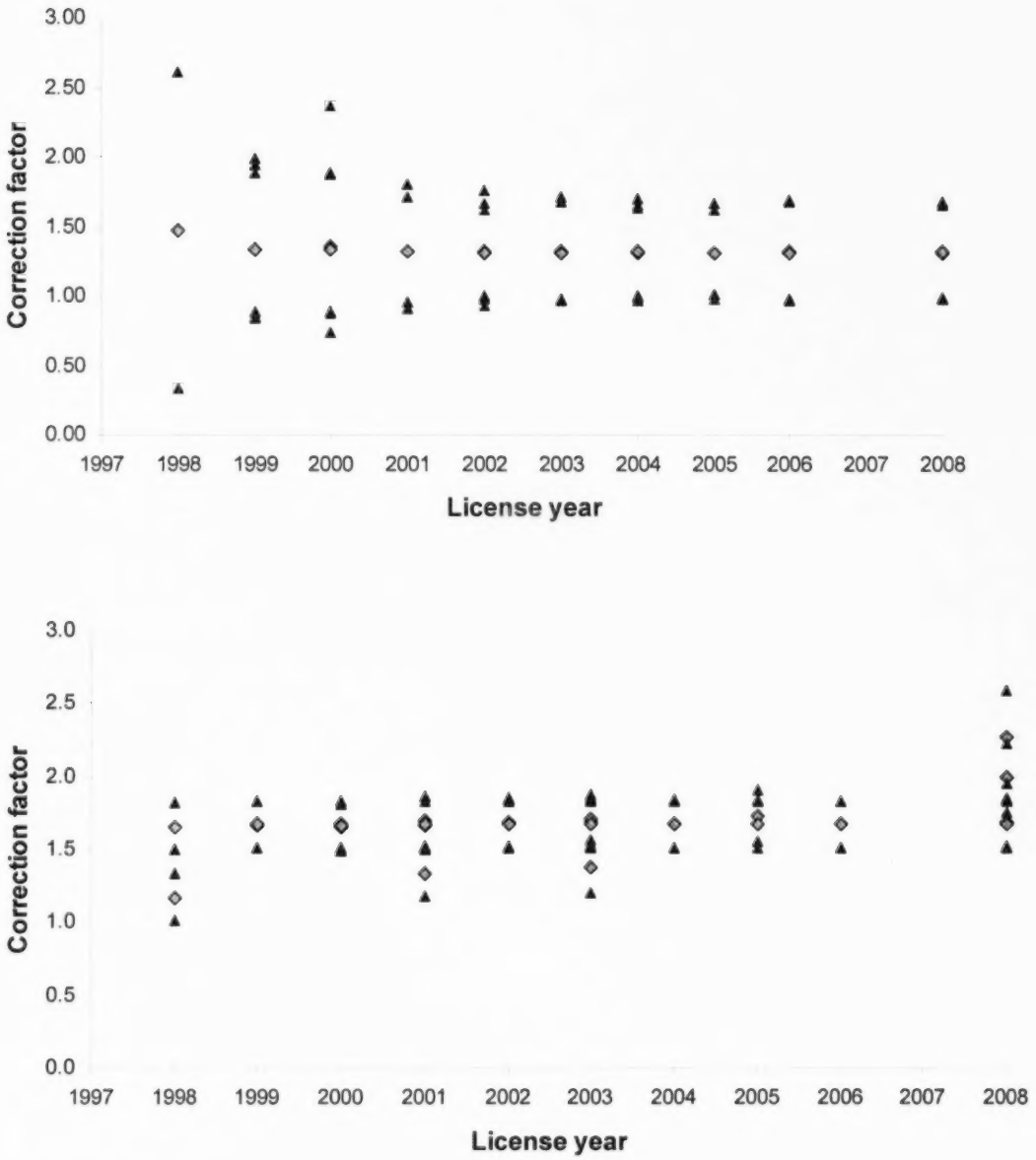

Figure 6. Correction factors for the number of Chinook released in retention periods as reported in logbooks for the period 1998-2008. Values derived from the PR Method (upper panel) and RFE Method (lower panel) are separately shown. Diamonds: mean values. Triangles: lower and upper 95% CL. Multiple sets of means and CLs, representing individual management areas, are shown.

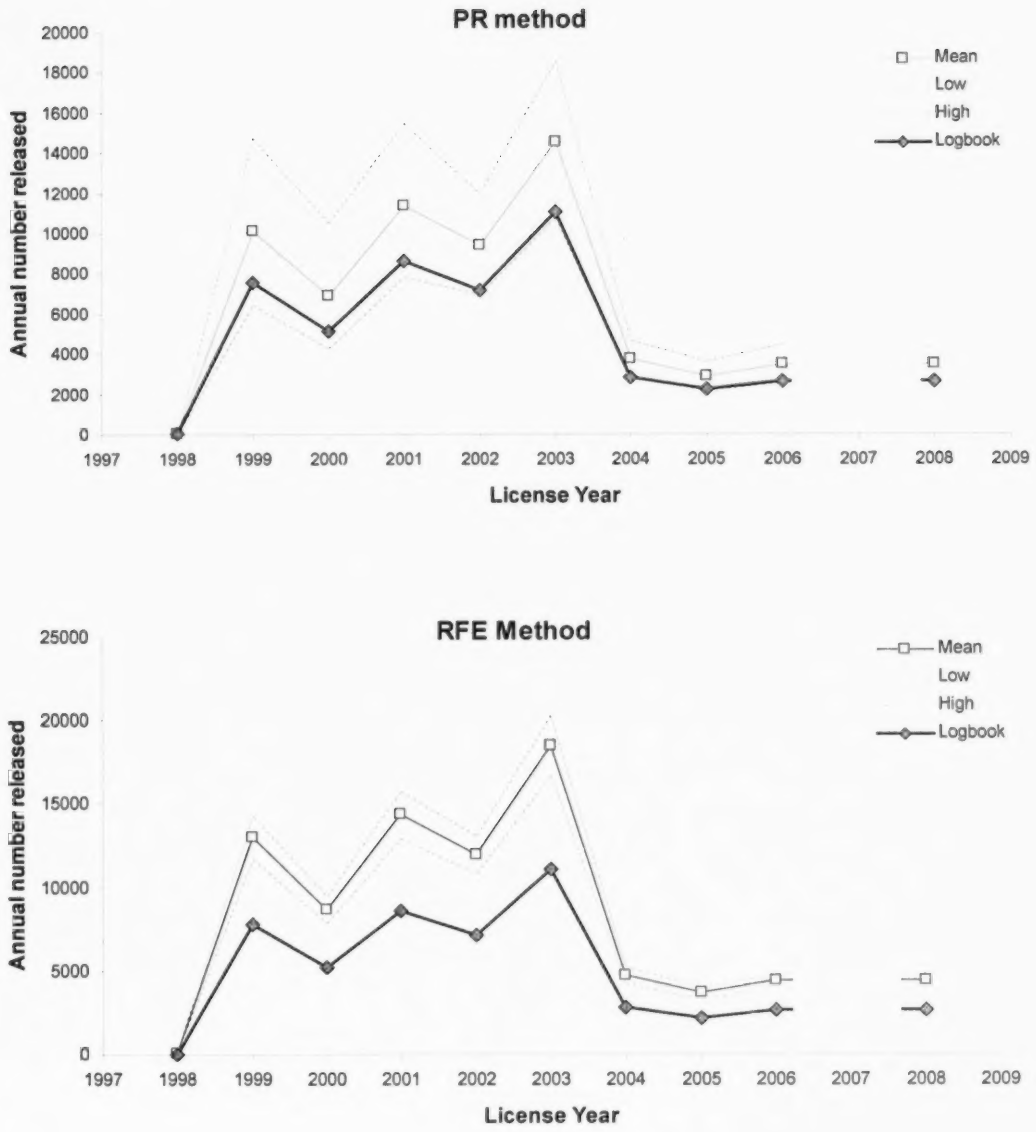

Figure 7. Number of Chinook released per license year as recorded in logbooks and derived from PR (*PR* metric applied to MA-LY stratification) and RFE (*RFE* metric applied to MA-SW stratification) methods. Only paired statistical strata and management areas with more than 40 boat hrs per year of observer representation were used for this comparison. Mean and 95% confidence intervals of the estimated annual number released are shown.

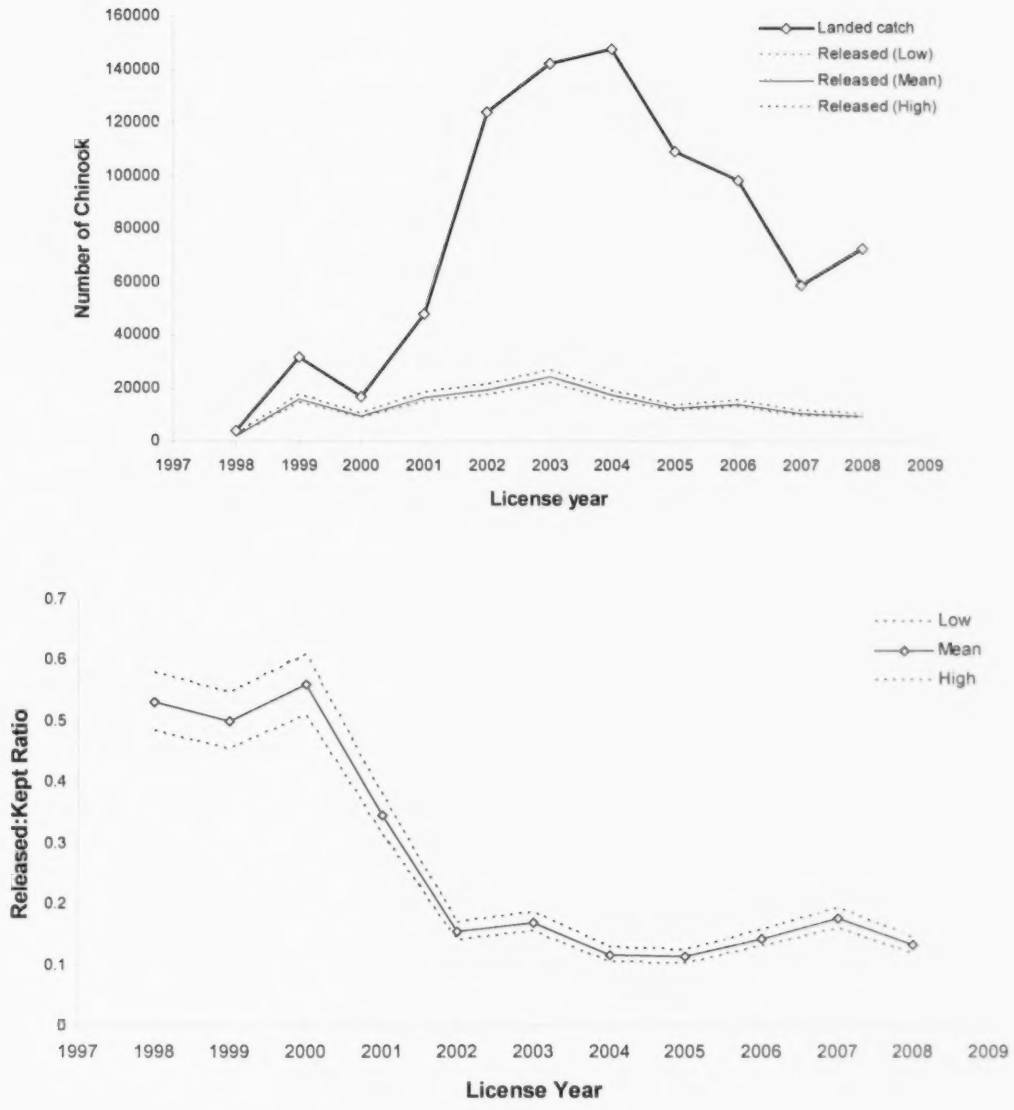

Figure 8. Landed catch and expanded number of Chinook released (upper panel) and corresponding released-kept ratios (lower panel) in troll fisheries in WCVI during the period 1998-2008. Mean and 95% confidence intervals are shown for the estimated annual number released and the released-kept ratio.

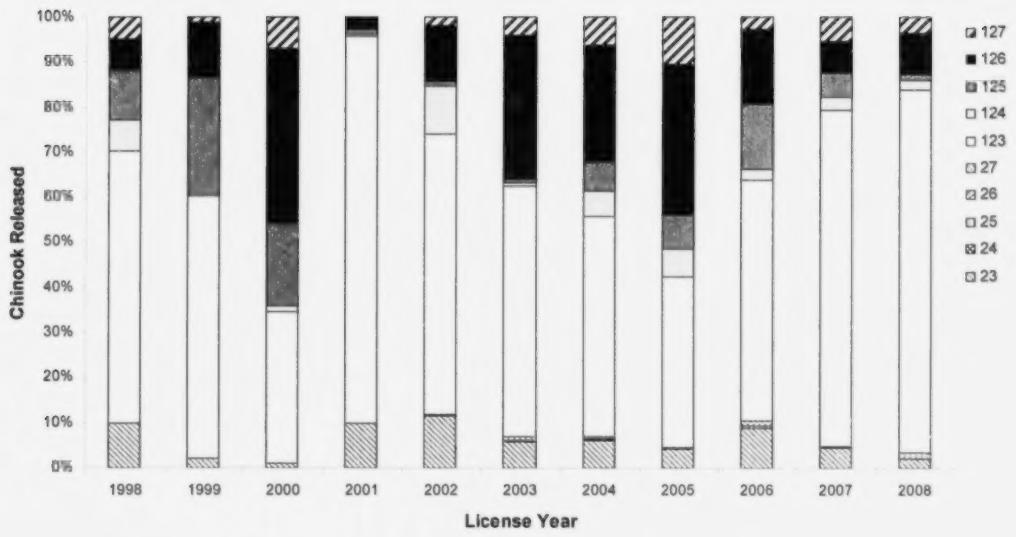

Figure 9. Percentage of the total number of Chinook salmon released by individual management areas (23-127) in a given license year.

APPENDIX

Number of Chinook released in retention periods as reported by logbooks and observers by license year, management area, and statistical week, and the mean and 95% CI (Low, High) of their corrected values.

License Year	Management Area	Statistical Week	Logbook Released	Observer Released	Corrected Released		
					Low	Mean	High
1998	23	07/1	2	52	52	52	52
1998	23	07/2		62	62	62	62
1998	23	07/3	35	14	46	49	52
1998	23	07/4	27		41	45	49
1998	25	11/2	0		0	0	0
1998	123	10/2	79		119	132	145
1998	123	10/3	176		266	294	323
1998	123	10/4	328		495	548	601
1998	123	10/5	21		32	35	38
1998	123	11/1	95		143	159	174
1998	123	11/2	51		77	85	93
1998	124	10/4	80		121	134	147
1998	124	11/1	4		6	7	7
1998	125	10/4	31		47	52	57
1998	125	10/5	6		9	10	11
1998	125	11/1	27		41	45	49
1998	125	11/2	18		27	30	33
1998	125	11/3	17		26	28	31
1998	125	11/4	29		44	48	53
1998	125	12/1	10		15	17	18
1998	126	10/4	39		59	65	71
1998	126	11/2	18		27	30	33
1998	126	11/3	17		26	28	31
1998	126	11/4	12		18	20	22
1998	127	10/4	61		92	102	112
1999	23	07/2	230	48	323	352	382
1999	23	07/3	0		0	0	0
1999	23	07/4	0		0	0	0
1999	123	10/1	517	31	765	843	922
1999	123	10/2	1503	150	2192	2411	2630
1999	123	10/3	1562	158	2277	2504	2731
1999	123	10/4	2152	164	3165	3486	3807
1999	124	10/1	10		15	17	18
1999	124	10/2	1		2	2	2
1999	124	10/3	0		0	0	0
1999	124	10/4	32		48	53	59
1999	125	10/1	40		60	67	73
1999	125	10/2	393	134	525	567	609
1999	125	10/3	1019	109	1483	1630	1777
1999	125	10/4	1078		1627	1801	1976
1999	126	10/1	97		146	162	178
1999	126	10/2	297		448	496	544
1999	126	10/3	401		605	670	735
1999	126	10/4	417	45	606	667	727

1999	127	10/1	68		103	114	125
1999	127	10/2	8		12	13	15
1999	127	10/3	8		12	13	15
1999	127	10/4	6		9	10	11
2000	23	06/4	48	9	68	74	80
2000	23	07/1	20		30	33	37
2000	123	10/2	935	141	1339	1468	1596
2000	123	10/3	876	239	1200	1303	1406
2000	123	11/4	21		32	35	38
2000	123	12/1	40		60	67	73
2000	123	12/2	68		103	114	125
2000	123	12/3	32		48	53	59
2000	123	12/4	14		21	23	26
2000	123	12/5	67		101	112	123
2000	124	10/2	46		69	77	84
2000	124	10/3	31		47	52	57
2000	125	10/2	431	44	628	691	753
2000	125	10/3	638	40	943	1039	1136
2000	126	10/2	1033	56	1531	1689	1846
2000	126	10/3	1232	55	1832	2022	2212
2000	127	10/2	187	12	276	304	333
2000	127	10/3	247	84	330	356	383
2001	23	01/1	23		35	38	42
2001	23	01/2	46		69	77	84
2001	23	01/3	186		281	311	341
2001	23	01/4	108		163	180	198
2001	23	01/5	70		106	117	128
2001	23	04/4	117		177	196	214
2001	23	04/5	66		100	110	121
2001	23	05/1	25		38	42	46
2001	23	05/2	20		30	33	37
2001	23	06/3	6		9	10	11
2001	23	07/1	11		17	18	20
2001	23	12/1	66		100	110	121
2001	23	12/2	167		252	279	306
2001	23	12/3	59		89	99	108
2001	23	12/4	16		24	27	29
2001	23	12/5	9		14	15	16
2001	123	01/2	10		15	17	18
2001	123	01/3	94		142	157	172
2001	123	01/5	72		109	120	132
2001	123	04/4	1172	88	1724	1899	2075
2001	123	04/5	1008	107	1467	1613	1758
2001	123	05/1	847	77	1239	1364	1488
2001	123	05/2	448	37	657	724	790
2001	123	05/3	1274	43	1901	2100	2299
2001	123	05/4	723	3	1090	1206	1322
2001	123	09/3	2541	276	3695	4061	4427
2001	123	10/2	125	66	155	165	174
2001	123	10/3	255	62	353	385	416
2001	123	10/4	8		12	13	15
2001	123	10/5	13		20	22	24

2001	123	11/1	21		32	35	38
2001	123	11/2	22		33	37	40
2001	123	11/4	25		38	42	46
2001	123	12/1	62		94	104	114
2001	123	12/3	32		48	53	59
2001	123	12/5	22		33	37	40
2001	124	04/4	2		3	3	4
2001	124	04/5	4		6	7	7
2001	124	05/1	26	0	39	43	48
2001	124	05/2	12		18	20	22
2001	124	05/3	15		23	25	27
2001	124	05/4	2		3	3	4
2001	124	09/3	0		0	0	0
2001	124	10/2	3	1	4	4	5
2001	124	10/3	8		12	13	15
2001	125	10/2	73		110	122	134
2001	125	10/3	30		45	50	55
2001	126	10/2	17		26	28	31
2001	126	10/3	193	28	277	304	330
2001	126	10/4	61		92	102	112
2002	23	01/2	253		382	423	464
2002	23	01/3	259		391	433	475
2002	23	01/4	92		139	154	169
2002	23	01/5	71		107	119	130
2002	23	02/1	230		347	384	421
2002	23	02/4	26		39	43	48
2002	23	03/1	62		94	104	114
2002	23	03/2	11		17	18	20
2002	23	06/2	7		11	12	13
2002	23	06/3	4		6	7	7
2002	23	06/4	2		3	3	4
2002	23	07/2	0		0	0	0
2002	23	07/3	21		32	35	38
2002	23	11/1	0		0	0	0
2002	23	11/4	23		35	38	42
2002	23	12/1	65		98	109	119
2002	23	12/2	71		107	119	130
2002	23	12/3	114		172	190	209
2002	23	12/4	23		35	38	42
2002	23	12/5	5		8	8	9
2002	25	06/3	1		2	2	2
2002	27	05/2	1		2	2	2
2002	27	11/4	2		3	3	4
2002	27	12/3	10		15	17	18
2002	27	12/4	4		6	7	7
2002	123	01/2	9		14	15	16
2002	123	01/3	14		21	23	26
2002	123	01/5	4		6	7	7
2002	123	02/1	10		15	17	18
2002	123	02/4	21		32	35	38
2002	123	03/1	50		75	84	92
2002	123	03/2	50		75	84	92

2002	123	04/3	80	109	65	61	56
2002	123	04/4	472	61	681	748	814
2002	123	04/5	572	23	852	940	1029
2002	123	05/1	835	22	1249	1381	1512
2002	123	05/2	885	26	1323	1461	1600
2002	123	05/3	1439	84	2129	2348	2567
2002	123	05/4	696	24	1038	1147	1256
2002	123	06/1	505		762	844	925
2002	123	06/2	401		605	670	735
2002	123	06/3	331		500	553	607
2002	123	08/3	115	132	106	104	101
2002	123	09/4	27		41	45	49
2002	123	10/1	559	26	831	917	1003
2002	123	10/2	246		371	411	451
2002	123	11/3	29		44	48	53
2002	123	11/4	32		48	53	59
2002	123	12/4	7		11	12	13
2002	123	12/5	4		6	7	7
2002	124	02/4	1		2	2	2
2002	124	03/1	15		23	25	27
2002	124	04/3	276	0	417	461	506
2002	124	04/4	49		74	82	90
2002	124	04/5	91		137	152	167
2002	124	05/1	107		162	179	196
2002	124	05/2	86		130	144	158
2002	124	05/3	38		57	63	70
2002	124	05/4	89		134	149	163
2002	124	06/1	261	7	390	431	472
2002	124	06/2	161	5	240	266	291
2002	124	06/3	23		35	38	42
2002	124	09/3	6	0	9	10	11
2002	124	09/4	12		18	20	22
2002	124	10/1	0		0	0	0
2002	125	02/4	0		0	0	0
2002	125	03/1	0		0	0	0
2002	125	04/3	32	0	48	53	59
2002	125	04/4	2		3	3	4
2002	125	05/1	7		11	12	13
2002	125	05/2	1		2	2	2
2002	125	05/3	15		23	25	27
2002	125	05/4	4		6	7	7
2002	125	06/1	18		27	30	33
2002	125	06/2	14		21	23	26
2002	125	06/3	5		8	8	9
2002	125	09/3	5		8	8	9
2002	125	09/4	27		41	45	49
2002	126	02/4	1		2	2	2
2002	126	03/1	4		6	7	7
2002	126	03/2	2		3	3	4
2002	126	04/3	44	0	66	74	81
2002	126	04/4	187	5	280	309	339
2002	126	04/5	139	3	208	230	252

2002	126	05/1	133	0	201	222	244
2002	126	05/2	57		86	95	104
2002	126	05/3	202		305	338	370
2002	126	05/4	112		169	187	205
2002	126	06/1	58	1	87	96	105
2002	126	06/2	70		106	117	128
2002	126	06/3	15		23	25	27
2002	126	09/3	39	1	58	64	71
2002	126	09/4	211	7	315	348	381
2002	126	10/1	148		223	247	271
2002	126	10/2	17		26	28	31
2002	127	02/4	1		2	2	2
2002	127	03/1	0		0	0	0
2002	127	04/3	1		2	2	2
2002	127	04/4	6		9	10	11
2002	127	04/5	34		51	57	62
2002	127	05/1	33		50	55	60
2002	127	05/2	28		42	47	51
2002	127	05/3	14		21	23	26
2002	127	05/4	14		21	23	26
2002	127	06/1	65		98	109	119
2002	127	09/4	20		30	33	37
2003	23	01/2	138		208	231	253
2003	23	01/3	101		152	169	185
2003	23	01/4	44		66	74	81
2003	23	01/5	22		33	37	40
2003	23	02/1	44		66	74	81
2003	23	02/2	33		50	55	60
2003	23	02/3	54		82	90	99
2003	23	02/4	64		97	107	117
2003	23	03/1	95		143	159	174
2003	23	03/2	25		38	42	46
2003	23	03/3	14		21	23	26
2003	23	03/4	47		71	79	86
2003	23	04/1	41		62	69	75
2003	23	04/3	19		29	32	35
2003	23	04/4	4		6	7	7
2003	23	04/5	16		24	27	29
2003	23	05/1	3		5	5	5
2003	23	05/3	2	2	2	2	2
2003	23	06/1	8		12	13	15
2003	23	06/4	0		0	0	0
2003	23	08/4	1		2	2	2
2003	23	09/2	1		2	2	2
2003	23	12/1	23		35	38	42
2003	23	12/2	14		21	23	26
2003	23	12/3	26		39	43	48
2003	23	12/4	7		11	12	13
2003	24	02/1	23		35	38	42
2003	24	02/2	6		9	10	11
2003	25	04/4	2		3	3	4
2003	26	03/1	7		11	12	13

2003	26	03/3	5		8	8	9
2003	26	03/4	11		17	18	20
2003	26	04/4	2		3	3	4
2003	26	04/5	1		2	2	2
2003	27	01/4	0		0	0	0
2003	27	02/1	2		3	3	4
2003	27	03/3	3		5	5	5
2003	27	03/4	2		3	3	4
2003	27	04/3	2		3	3	4
2003	27	04/4	3		5	5	5
2003	27	04/5	8		12	13	15
2003	27	05/1	23		35	38	42
2003	27	05/2	23		35	38	42
2003	27	06/1	22		33	37	40
2003	27	12/1	1		2	2	2
2003	123	01/2	18		27	30	33
2003	123	01/3	28		42	47	51
2003	123	01/4	48		72	80	88
2003	123	01/5	61		92	102	112
2003	123	02/1	29		44	48	53
2003	123	02/2	67		101	112	123
2003	123	02/3	47		71	79	86
2003	123	02/4	31		47	52	57
2003	123	03/1	44		66	74	81
2003	123	03/2	21		32	35	38
2003	123	04/3	77	16	108	118	128
2003	123	04/4	85	0	128	142	156
2003	123	04/5	359	51	516	566	615
2003	123	05/1	1051	102	1534	1688	1841
2003	123	05/2	1299	22	1950	2156	2362
2003	123	05/3	1792	132	2638	2906	3174
2003	123	06/1	1334	119	1953	2149	2346
2003	123	06/4	54		82	90	99
2003	123	10/1	1315	149	1909	2097	2286
2003	123	10/5	178		269	297	326
2003	123	11/1	255		385	426	467
2003	123	12/1	69		104	115	126
2003	123	12/2	30		45	50	55
2003	123	12/4	6		9	10	11
2003	124	01/5	1		2	2	2
2003	124	02/1	0		0	0	0
2003	124	02/4	1		2	2	2
2003	124	03/1	4		6	7	7
2003	124	03/2	1		2	2	2
2003	124	03/3	4		6	7	7
2003	124	03/4	0		0	0	0
2003	124	04/1	0		0	0	0
2003	124	04/3	16		24	27	29
2003	124	04/4	31	0	47	52	57
2003	124	04/5	4		6	7	7
2003	124	05/1	7		11	12	13
2003	124	05/2	16	0	24	27	29

2003	124	05/3	0		0	0	0
2003	124	06/1	3		5	5	5
2003	125	03/1	11		17	18	20
2003	125	03/2	19		29	32	35
2003	125	03/3	10		15	17	18
2003	125	03/4	23		35	38	42
2003	125	04/1	0		0	0	0
2003	125	04/3	40		60	67	73
2003	125	04/4	20		30	33	37
2003	125	04/5	7		11	12	13
2003	125	05/1	0		0	0	0
2003	125	05/2	2		3	3	4
2003	125	06/1	0		0	0	0
2003	126	01/5	10		15	17	18
2003	126	02/1	6		9	10	11
2003	126	02/2	25		38	42	46
2003	126	02/3	1		2	2	2
2003	126	02/4	14		21	23	26
2003	126	03/1	26		39	43	48
2003	126	03/2	4		6	7	7
2003	126	03/3	44		66	74	81
2003	126	03/4	28		42	47	51
2003	126	04/1	2		3	3	4
2003	126	04/3	378	27	557	614	670
2003	126	04/4	1056	36	1576	1740	1905
2003	126	04/5	696	24	1038	1147	1256
2003	126	05/1	900	42	1337	1476	1614
2003	126	05/2	671	6	1010	1117	1225
2003	126	05/3	367		554	613	673
2003	126	06/1	60		91	100	110
2003	126	10/1	361		545	603	662
2003	126	10/5	17		26	28	31
2003	126	11/1	8		12	13	15
2003	126	12/1	10		15	17	18
2003	127	02/4	3		5	5	5
2003	127	03/2	0		0	0	0
2003	127	03/3	4		6	7	7
2003	127	03/4	0		0	0	0
2003	127	04/1	1		2	2	2
2003	127	04/3	1		2	2	2
2003	127	04/4	18		27	30	33
2003	127	04/5	125		189	209	229
2003	127	05/1	153	0	231	256	280
2003	127	05/2	145		219	242	266
2003	127	05/3	80		121	134	147
2003	127	06/1	34		51	57	62
2003	127	10/1	3		5	5	5
2004	23	01/3	196		296	328	359
2004	23	01/4	103		155	172	189
2004	23	01/5	14		21	23	26
2004	23	02/2	189		285	316	346
2004	23	03/4	14		21	23	26

2004	23	04/1	57		86	95	104
2004	23	04/2	9		14	15	16
2004	23	04/4	0		0	0	0
2004	23	05/1	12		18	20	22
2004	23	05/2	0		0	0	0
2004	23	05/3	0		0	0	0
2004	23	08/3	13		20	22	24
2004	23	08/4	1		2	2	2
2004	23	09/2	3		5	5	5
2004	23	11/1	10		15	17	18
2004	23	12/2	3		5	5	5
2004	23	12/3	6		9	10	11
2004	23	12/4	7		11	12	13
2004	25	02/2	2		3	3	4
2004	25	03/1	1		2	2	2
2004	25	03/4	5		8	8	9
2004	25	08/3	23		35	38	42
2004	25	08/4	0		0	0	0
2004	26	01/3	1		2	2	2
2004	26	02/4	1		2	2	2
2004	26	03/1	0		0	0	0
2004	26	03/2	2		3	3	4
2004	26	03/4	0		0	0	0
2004	26	05/2	0		0	0	0
2004	26	09/3	9		14	15	16
2004	26	09/4	21		32	35	38
2004	27	02/2	6		9	10	11
2004	27	04/1	3		5	5	5
2004	123	01/3	72		109	120	132
2004	123	02/2	68		103	114	125
2004	123	04/3	174		263	291	319
2004	123	04/4	877		1324	1465	1607
2004	123	04/5	1208	21	1813	2004	2196
2004	123	05/1	958	47	1422	1569	1716
2004	123	10/1	445		672	744	816
2004	123	11/1	1228		1854	2052	2250
2004	123	12/2	0		0	0	0
2004	123	12/4	2		3	3	4
2004	124	02/2	7		11	12	13
2004	124	04/2	8		12	13	15
2004	124	04/3	4		6	7	7
2004	124	04/4	7		11	12	13
2004	124	04/5	21		32	35	38
2004	124	05/1	24		36	40	44
2004	124	05/2	207	12	306	338	369
2004	124	05/3	202	2	304	336	369
2004	124	09/3	23		35	38	42
2004	124	09/4	24		36	40	44
2004	124	10/1	8		12	13	15
2004	124	11/1	50		75	84	92
2004	125	01/3	5		8	8	9
2004	125	01/5	2		3	3	4

2004	125	02/2	12		18	20	22
2004	125	02/4	8		12	13	15
2004	125	03/1	54		82	90	99
2004	125	03/2	92		139	154	169
2004	125	03/3	58		88	97	106
2004	125	03/4	29		44	48	53
2004	125	04/1	18		27	30	33
2004	125	04/2	21		32	35	38
2004	125	04/3	17		26	28	31
2004	125	04/4	11		17	18	20
2004	125	04/5	17		26	28	31
2004	125	05/1	9		14	15	16
2004	125	05/2	33		50	55	60
2004	125	05/3	29		44	48	53
2004	125	09/3	74		112	124	136
2004	125	09/4	51		77	85	93
2004	125	10/1	119		180	199	218
2004	126	01/3	11		17	18	20
2004	126	02/2	40		60	67	73
2004	126	02/4	56		85	94	103
2004	126	03/1	45		68	75	82
2004	126	03/2	210		317	351	385
2004	126	03/3	136		205	227	249
2004	126	03/4	182		275	304	334
2004	126	04/1	119		180	199	218
2004	126	04/2	81		122	135	148
2004	126	04/3	203		306	339	372
2004	126	04/4	153		231	256	280
2004	126	04/5	155		234	259	284
2004	126	05/1	67		101	112	123
2004	126	05/2	143		216	239	262
2004	126	05/3	131		198	219	240
2004	126	09/3	516	6	776	858	941
2004	126	09/4	224	13	331	366	400
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2004	127	02/2	6		9	10	11
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2004	127	03/3	1		2	2	2
2004	127	03/4	13		20	22	24
2004	127	04/1	17		26	28	31
2004	127	04/2	21		32	35	38
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2004	127	04/4	36		54	60	66
2004	127	04/5	45		68	75	82
2004	127	05/1	36		54	60	66
2004	127	05/2	82		124	137	150
2004	127	05/3	96		145	160	176
2004	127	09/3	74		112	124	136
2004	127	09/4	111		168	185	203
2004	127	10/1	73		110	122	134
2005	23	01/2	30		45	50	55

2005	23	01/3	34		51	57	62
2005	23	02/1	62		94	104	114
2005	23	02/2	33		50	55	60
2005	23	02/3	39		59	65	71
2005	23	03/1	37		56	62	68
2005	23	03/2	41		62	69	75
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2005	23	03/4	9		14	15	16
2005	23	05/2	11		17	18	20
2005	23	08/3	0		0	0	0
2005	23	08/4	0		0	0	0
2005	23	09/1	0		0	0	0
2005	23	12/2	11		17	18	20
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2005	24	03/1	0		0	0	0
2005	24	03/2	2		3	3	4
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2005	24	03/4	0		0	0	0
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2005	25	03/4	0		0	0	0
2005	25	08/2	0		0	0	0
2005	26	02/3	2		3	3	4
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2005	123	02/1	23		35	38	42
2005	123	02/2	14		21	23	26
2005	123	02/3	14		21	23	26
2005	123	04/5	492	76	704	771	838
2005	123	05/1	277	5	416	460	503
2005	123	05/2	675	0	1019	1128	1237
2005	123	10/1	194		293	324	356
2005	123	10/2	484		731	809	887
2005	123	10/3	7		11	12	13
2005	123	11/2	507		765	847	929
2005	123	12/2	109		165	182	200
2005	124	01/3	10		15	17	18
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2005	124	02/3	10		15	17	18
2005	124	04/5	31		47	52	57
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2005	124	09/3	26	0	39	43	48
2005	124	09/4	121		183	202	222
2005	124	10/1	183		276	306	335
2005	124	10/2	75		113	125	137
2005	124	11/2	3		5	5	5

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2005	125	02/3	15		23	25	27
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2005	125	03/2	15		23	25	27
2005	125	03/3	16		24	27	29
2005	125	03/4	10		15	17	18
2005	125	04/1	0		0	0	0
2005	125	04/2	52	0	78	87	95
2005	125	04/3	13	0	20	22	24
2005	125	04/4	43	0	65	72	79
2005	125	04/5	179	1	270	298	327
2005	125	05/1	101		152	169	185
2005	125	05/2	84		127	140	154
2005	125	09/3	9	1	13	14	16
2005	125	09/4	11	0	17	18	20
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2005	126	02/1	60		91	100	110
2005	126	02/2	134		202	224	246
2005	126	02/3	43		65	72	79
2005	126	03/1	28		42	47	51
2005	126	03/2	26		39	43	48
2005	126	03/3	13		20	22	24
2005	126	03/4	22		33	37	40
2005	126	04/1	7		11	12	13
2005	126	04/2	304	0	459	508	557
2005	126	04/3	153	0	231	256	280
2005	126	04/4	580	5	873	966	1059
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2005	126	05/1	190	0	287	317	348
2005	126	05/2	89	0	134	149	163
2005	126	09/3	74	10	107	117	127
2005	126	09/4	254	1	383	424	465
2005	126	10/1	38		57	63	70
2005	126	10/2	15		23	25	27
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2005	127	03/3	4		6	7	7
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2005	127	04/2	30		45	50	55
2005	127	04/3	16		24	27	29
2005	127	04/4	33		50	55	60
2005	127	04/5	41		62	69	75
2005	127	05/1	4		6	7	7

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2005	127	09/3	143	216	239	262
2005	127	09/4	324	489	541	594
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2005	127	10/2	3	5	5	5
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2006	23	01/2	35	53	58	64
2006	23	01/3	38	57	63	70
2006	23	01/4	7	11	12	13
2006	23	01/5	49	74	82	90
2006	23	02/1	70	106	117	128
2006	23	02/2	8	12	13	15
2006	23	02/3	40	60	67	73
2006	23	02/4	47	71	79	86
2006	23	03/1	19	29	32	35
2006	23	03/2	19	29	32	35
2006	23	03/3	76	115	127	139
2006	23	03/4	171	258	286	313
2006	23	04/3	27	41	45	49
2006	23	04/4	17	26	28	31
2006	23	04/5	3	5	5	5
2006	23	11/3	15	23	25	27
2006	23	11/4	50	75	84	92
2006	23	12/1	30	45	50	55
2006	23	12/3	2	3	3	4
2006	24	02/2	0	0	0	0
2006	24	03/4	5	8	8	9
2006	24	04/5	0	0	0	0
2006	25	01/3	12	18	20	22
2006	25	01/4	12	18	20	22
2006	25	03/1	2	3	3	4
2006	25	04/1	0	0	0	0
2006	25	04/2	2	3	3	4
2006	25	04/3	2	3	3	4
2006	25	12/1	7	11	12	13
2006	26	01/3	6	9	10	11
2006	27	01/3	4	6	7	7
2006	27	01/5	18	27	30	33
2006	27	02/1	58	88	97	106
2006	27	02/3	0	0	0	0
2006	27	02/4	1	2	2	2
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2006	27	04/4	1	2	2	2
2006	27	12/2	1	2	2	2
2006	123	01/2	1	2	2	2
2006	123	01/3	4	6	7	7
2006	123	01/4	0	0	0	0
2006	123	01/5	22	33	37	40
2006	123	02/1	21	32	35	38
2006	123	02/2	2	3	3	4
2006	123	02/3	0	0	0	0
2006	123	02/4	4	6	7	7

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2006	123	04/4	220		332	368	403
2006	123	04/5	320		483	535	586
2006	123	06/1	67		101	112	123
2006	123	06/2	963	0	1454	1609	1765
2006	123	06/3	130	0	196	217	238
2006	123	08/3	1		2	2	2
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2006	123	11/1	135		204	226	247
2006	123	11/3	12		18	20	22
2006	123	11/4	1		2	2	2
2006	124	01/3	17		26	28	31
2006	124	01/4	2		3	3	4
2006	124	01/5	23		35	38	42
2006	124	02/1	5		8	8	9
2006	124	02/2	0		0	0	0
2006	124	02/3	7		11	12	13
2006	124	03/1	6		9	10	11
2006	124	04/3	0		0	0	0
2006	124	04/4	0		0	0	0
2006	124	04/5	1		2	2	2
2006	124	06/2	4		6	7	7
2006	124	06/3	0		0	0	0
2006	124	08/3	0		0	0	0
2006	124	08/4	2		3	3	4
2006	124	09/2	54		82	90	99
2006	124	10/1	75		113	125	137
2006	124	11/1	0		0	0	0
2006	124	12/1	3		5	5	5
2006	125	01/3	16		24	27	29
2006	125	01/4	10		15	17	18
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2006	125	02/2	2		3	3	4
2006	125	03/1	3		5	5	5
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2006	125	03/3	14		21	23	26
2006	125	03/4	23		35	38	42
2006	125	04/1	35		53	58	64
2006	125	04/2	86		130	144	158
2006	125	04/3	4		6	7	7
2006	125	04/4	3		5	5	5
2006	125	04/5	0		0	0	0
2006	125	06/2	6	0	9	10	11
2006	125	06/3	18	0	27	30	33
2006	125	08/3	2		3	3	4
2006	125	08/4	3		5	5	5
2006	125	09/1	594	5	894	989	1084
2006	125	09/2	361	6	542	599	657
2006	125	09/3	38	0	57	63	70

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2006	126	01/3	132		199	221	242
2006	126	01/4	97		146	162	178
2006	126	01/5	187		282	312	343
2006	126	02/1	32		48	53	59
2006	126	02/2	4		6	7	7
2006	126	02/3	17		26	28	31
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2006	126	03/1	0		0	0	0
2006	126	03/2	1		2	2	2
2006	126	03/3	13		20	22	24
2006	126	03/4	38		57	63	70
2006	126	04/1	14		21	23	26
2006	126	04/2	13		20	22	24
2006	126	04/3	11		17	18	20
2006	126	04/4	10		15	17	18
2006	126	04/5	4		6	7	7
2006	126	06/1	1		2	2	2
2006	126	06/2	28		42	47	51
2006	126	06/3	47	0	71	79	86
2006	126	08/3	0		0	0	0
2006	126	08/4	2		3	3	4
2006	126	09/1	230	0	347	384	421
2006	126	09/2	98		148	164	180
2006	126	09/3	85		128	142	156
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2006	126	11/4	44		66	74	81
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2006	126	12/2	11		17	18	20
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2006	127	01/5	3		5	5	5
2006	127	02/4	6		9	10	11
2006	127	03/3	0		0	0	0
2006	127	03/4	0		0	0	0
2006	127	04/1	10		15	17	18
2006	127	04/2	15		23	25	27
2006	127	04/3	1		2	2	2
2006	127	04/4	12		18	20	22
2006	127	04/5	25		38	42	46
2006	127	06/2	26		39	43	48
2006	127	06/3	84		127	140	154
2006	127	08/3	0	0	0	0	0
2006	127	08/4	0	0	0	0	0
2006	127	09/1	12	0	18	20	22
2006	127	09/2	16		24	27	29
2006	127	09/3	15		23	25	27
2006	127	09/4	6		9	10	11
2006	127	10/1	1		2	2	2
2007	23	01/3	24		36	40	44

2007	23	01/4	10	15	17	18
2007	23	01/5	15	23	25	27
2007	23	02/1	21	32	35	38
2007	23	02/2	20	30	33	37
2007	23	02/3	15	23	25	27
2007	23	02/4	19	29	32	35
2007	23	04/1	11	17	18	20
2007	23	04/2	26	39	43	48
2007	23	04/3	9	14	15	16
2007	23	04/4	1	2	2	2
2007	23	04/5	12	18	20	22
2007	23	05/1	44	66	74	81
2007	23	05/2	9	14	15	16
2007	23	06/1	38	57	63	70
2007	23	06/2	5	8	8	9
2007	23	06/3	6	9	10	11
2007	24	02/1	1	2	2	2
2007	24	02/2	2	3	3	4
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2007	24	04/2	0	0	0	0
2007	24	04/3	0	0	0	0
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2007	26	04/4	0	0	0	0
2007	27	04/5	3	5	5	5
2007	123	01/3	29	44	48	53
2007	123	01/4	0	0	0	0
2007	123	01/5	2	3	3	4
2007	123	02/1	19	29	32	35
2007	123	02/2	11	17	18	20
2007	123	02/3	4	6	7	7
2007	123	02/4	5	8	8	9
2007	123	04/3	87	131	145	159
2007	123	04/4	46	69	77	84
2007	123	04/5	172	260	287	315
2007	123	05/1	148	223	247	271
2007	123	05/2	399	602	667	731
2007	123	05/3	508	767	849	931
2007	123	05/4	152	229	254	279
2007	123	06/1	136	205	227	249
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2007	123	06/3	314	474	525	575
2007	123	09/3	1592	2403	2660	2917
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2007	123	10/4	519	783	867	951
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2007	124	02/1	3	5	5	5
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2007	124	04/3	0	0	0	0
2007	124	04/5	0	0	0	0
2007	124	05/1	1	2	2	2
2007	124	05/2	0	0	0	0
2007	124	05/3	2	3	3	4
2007	124	05/4	15	23	25	27
2007	124	06/1	24	36	40	44
2007	124	06/2	9	14	15	16
2007	124	06/3	92	139	154	169
2007	124	09/3	7	11	12	13
2007	124	10/3	0	0	0	0
2007	125	01/3	10	15	17	18
2007	125	01/4	0	0	0	0
2007	125	01/5	5	8	8	9
2007	125	02/1	3	5	5	5
2007	125	02/4	1	2	2	2
2007	125	04/2	2	3	3	4
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2007	125	04/5	0	0	0	0
2007	125	05/1	0	0	0	0
2007	125	05/2	3	5	5	5
2007	125	05/3	5	8	8	9
2007	125	05/4	15	23	25	27
2007	125	06/1	55	83	92	101
2007	125	06/2	1	2	2	2
2007	125	06/3	122	184	204	224
2007	125	09/3	15	23	25	27
2007	125	09/4	20	30	33	37
2007	125	10/3	6	9	10	11
2007	125	10/4	58	88	97	106
2007	126	01/3	51	77	85	93
2007	126	01/4	15	23	25	27
2007	126	01/5	31	47	52	57
2007	126	02/1	10	15	17	18
2007	126	02/2	21	32	35	38
2007	126	02/3	26	39	43	48
2007	126	02/4	7	11	12	13
2007	126	04/1	0	0	0	0
2007	126	04/2	31	47	52	57
2007	126	04/3	10	15	17	18
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2007	126	04/5	6	9	10	11
2007	126	05/1	4	6	7	7
2007	126	05/2	1	2	2	2
2007	126	05/3	18	27	30	33
2007	126	05/4	31	47	52	57
2007	126	06/1	48	72	80	88
2007	126	06/2	0	0	0	0
2007	126	06/3	56	85	94	103
2007	126	09/3	6	9	10	11

2007	126	09/4	5	8	8	9
2007	126	10/3	0	0	0	0
2007	126	10/4	46	69	77	84
2007	127	01/4	1	2	2	2
2007	127	01/5	0	0	0	0
2007	127	04/2	1	2	2	2
2007	127	04/3	2	3	3	4
2007	127	04/4	1	2	2	2
2007	127	04/5	6	9	10	11
2007	127	05/1	4	6	7	7
2007	127	05/2	1	2	2	2
2007	127	05/3	19	29	32	35
2007	127	05/4	44	66	74	81
2007	127	06/1	81	122	135	148
2007	127	06/2	0	0	0	0
2007	127	06/3	89	134	149	163
2007	127	09/3	58	88	97	106
2007	127	09/4	32	48	53	59
2008	23	01/2	40	60	67	73
2008	23	01/3	18	27	30	33
2008	23	01/4	10	15	17	18
2008	23	01/5	7	11	12	13
2008	23	02/1	6	9	10	11
2008	23	02/4	0	0	0	0
2008	23	03/2	3	5	5	5
2008	23	04/4	3	5	5	5
2008	23	04/5	0	0	0	0
2008	23	05/1	0	0	0	0
2008	23	05/2	0	0	0	0
2008	23	05/3	0	0	0	0
2008	23	06/1	3	5	5	5
2008	23	06/2	11	17	18	20
2008	23	12/1	20	30	33	37
2008	24	04/4	0	0	0	0
2008	24	04/5	0	0	0	0
2008	25	01/2	0	0	0	0
2008	25	01/5	42	63	70	77
2008	25	02/1	33	50	55	60
2008	25	02/4	5	8	8	9
2008	27	01/2	2	3	3	4
2008	27	01/3	3	5	5	5
2008	27	01/4	1	2	2	2
2008	27	02/1	0	0	0	0
2008	27	02/3	0	0	0	0
2008	27	03/1	0	0	0	0
2008	27	03/2	0	0	0	0
2008	27	05/1	0	0	0	0
2008	27	12/1	0	0	0	0
2008	123	01/3	2	3	3	4
2008	123	01/4	1	2	2	2
2008	123	01/5	0	0	0	0
2008	123	02/1	4	6	7	7

2008	123	02/2	2		3	3	4
2008	123	02/3	3		5	5	5
2008	123	02/4	1		2	2	2
2008	123	05/1	18		27	30	33
2008	123	05/2	8		12	13	15
2008	123	05/3	8		12	13	15
2008	123	05/4	25		38	42	46
2008	123	06/1	12		18	20	22
2008	123	06/2	198		299	331	363
2008	123	06/3	62		94	104	114
2008	123	07/5	46	0	69	77	84
2008	123	08/1	90	1	135	150	164
2008	123	09/1	1667	92	2469	2724	2978
2008	123	09/2	780	13	1171	1295	1419
2008	123	09/4	1033		1559	1726	1893
2008	123	10/3	451		681	754	827
2008	123	10/4	164		248	274	301
2008	123	11/1	3		5	5	5
2008	123	11/2	29		44	48	53
2008	123	11/3	39		59	65	71
2008	123	12/1	3		5	5	5
2008	124	01/2	0		0	0	0
2008	124	01/3	0		0	0	0
2008	124	01/4	0		0	0	0
2008	124	02/1	0		0	0	0
2008	124	02/2	2		3	3	4
2008	124	02/3	0		0	0	0
2008	124	04/5	1		2	2	2
2008	124	05/1	2		3	3	4
2008	124	05/2	1		2	2	2
2008	124	05/3	2		3	3	4
2008	124	05/4	3		5	5	5
2008	124	06/1	2		3	3	4
2008	124	06/2	0		0	0	0
2008	124	07/5	0		0	0	0
2008	124	09/1	40		60	67	73
2008	124	09/2	2		3	3	4
2008	124	09/4	66		100	110	121
2008	124	10/4	0		0	0	0
2008	124	11/3	0		0	0	0
2008	124	12/1	2		3	3	4
2008	125	01/3	2		3	3	4
2008	125	01/5	0		0	0	0
2008	125	02/1	1		2	2	2
2008	125	02/4	0		0	0	0
2008	125	03/2	1		2	2	2
2008	125	04/4	19		29	32	35
2008	125	04/5	1		2	2	2
2008	125	05/1	0		0	0	0
2008	125	05/2	0		0	0	0
2008	125	05/3	0		0	0	0
2008	125	05/4	0		0	0	0

2008	125	06/2	0	0	0	0
2008	125	07/5	0	0	0	0
2008	125	09/1	31	47	52	57
2008	125	09/2	7	11	12	13
2008	125	09/3	4	6	7	7
2008	125	09/4	2	3	3	4
2008	125	12/1	0	0	0	0
2008	126	01/2	0	0	0	0
2008	126	01/3	144	217	241	264
2008	126	01/4	25	38	42	46
2008	126	01/5	20	30	33	37
2008	126	02/1	16	24	27	29
2008	126	02/2	17	26	28	31
2008	126	02/3	6	9	10	11
2008	126	02/4	2	3	3	4
2008	126	03/1	2	3	3	4
2008	126	03/2	2	3	3	4
2008	126	04/4	13	20	22	24
2008	126	04/5	4	6	7	7
2008	126	05/1	8	12	13	15
2008	126	05/2	8	12	13	15
2008	126	05/3	1	2	2	2
2008	126	05/4	0	0	0	0
2008	126	06/1	1	2	2	2
2008	126	06/2	0	0	0	0
2008	126	06/3	0	0	0	0
2008	126	09/1	81	122	135	148
2008	126	09/2	6	9	10	11
2008	126	09/3	0	0	0	0
2008	126	09/4	0	0	0	0
2008	126	10/1	0	0	0	0
2008	126	10/3	20	30	33	37
2008	126	10/4	12	18	20	22
2008	126	11/2	20	30	33	37
2008	126	11/3	20	30	33	37
2008	126	12/1	97	146	162	178
2008	127	01/3	1	2	2	2
2008	127	02/1	0	0	0	0
2008	127	02/2	1	2	2	2
2008	127	02/3	0	0	0	0
2008	127	02/4	3	5	5	5
2008	127	03/1	1	2	2	2
2008	127	03/2	1	2	2	2
2008	127	04/4	0	0	0	0
2008	127	04/5	0	0	0	0
2008	127	05/1	2	3	3	4
2008	127	05/2	1	2	2	2
2008	127	05/3	1	2	2	2
2008	127	05/4	11	17	18	20
2008	127	06/1	12	18	20	22
2008	127	06/2	26	39	43	48
2008	127	06/3	1	2	2	2

2008	127	07/5	1	0	2	2	2
2008	127	08/1	2	0	3	3	4
2008	127	09/1	49		74	82	90
2008	127	09/2	52	0	78	87	95
2008	127	09/3	2		3	3	4
2008	127	09/4	34		51	57	62
2008	127	12/1	2		3	3	4